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AUTHOR Thomas, J. Alan
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ABSTRACT

This report deals with the allocation of resources within classrooms and homes. It is based on the assumption that learning occurs through a set of processes that require the utilization of human and material resources. It is assumed that the study of resource allocation at the micro level will help provide an understanding of the effect on learning of policies developed at the macro level and that both equity and efficiency are dependent on the availability to students of alternative mixes of purchased and unpurchased resources. The theoretical framework that is developed in this report is based on a systems approach that regards teachers, students, and parents as important allocators of resources. Students' time is treated as an input that has value and is analogous to teachers' time and material resources. Under certain circumstances, discussed the text, substitutions may be made among inputs; the technologies that are utilized within classrooms are based upon alternate combinations of resources. The report concludes with a proposal for the empirical testing of the theory. Data will be gathered through classroom observation and questionnaires, and comparisons will be made of various patterns of resource allocation among and within classrooms. (Author)

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FINAL REPORT

PROJECT NO. 4-0794
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RESOURCE ALLOCATION IN CLASSROOMS

J. ALAN THOMAS
UNIVERSITY OF CHICAGO
CHICAGO, ILLINOIS 60637

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PREFACE

I wish to acknowledge with gratitude the encouragement, criticism and advice I have received from past and present colleagues. Douglas Windham has been especially helpful in the development of the economic framework within which this analysis is placed, while many of the ideas which are presented in the Report have grown out of earlier discussions with Mary Jean Bowman. Colleagues in the Department of Education, The University of Chicago including Charles Bidwell, Benjamin Bloom, Robert Dreeben, Philip Jackson, Dan Lortie, and Susan Stodolsky have read and criticized various drafts of the material on which the Report is based. Their suggestions have helped shape the direction of my thinking and are, in many ways, reflected in the text of the Report. The errors, omissions, and inadequacies which remain are, of course, my own.

My students also have contributed substantially to the Report. Special mention is made of two doctoral students, Frances Kemmerer who provided valuable bibliographic assistance, and David Monk who contributed in important ways to the development of the analysis, especially in Chapters 4 and 5. Earlier versions of the text have been used by several of my classes in Systems Analysis in Education; the contributions of these students has been significant.

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Chapter 1

MANAGEMENT AND POLICY MAKING IN EDUCATION

Introduction

In this Report, educational organizations will be viewed as complex decision-making systems. Individuals occupying a variety of roles, including teacher, student, school board member, superintendent, or congressman, to name but a few, make decisions about the goals of educational systems and the means for attaining these goals. Decisions made by the occupants of one role affect the options available to decision-makers elsewhere in the system.[1]

Our perspective differs in several respects from that which prevails in most textbooks in school management and educational finance, as well as from the viewpoint of many economists and sociologists who conduct policy-related research. Much of the work conducted in those contexts is apparently based on the assumption that educational decision-making systems are hierarchical, so that decisions made at higher organizational levels determine behavior at the lower levels. We emphasize that this perspective is only partially valid, and that the production of education depends on decisions made within homes and classrooms, as well as in administrative offices.

The Report's emphasis is on a topic which, although given considerable attention in the literature of school finance and management, is seldom discussed in a comprehensive manner, namely the allocation of resources within educational systems. This Report provides a theoretical analysis of this phenomenon; this analysis will be followed by an empirical examination of the effect of decisions made by teachers, students, and parents on the flow of resources within classrooms.

The main premise which underlies our work is that policy and management decisions should reflect the manner in which education is "produced" in homes and classrooms. Hence, resource allocation decisions are unrealistic if they are not based on data related to micro-level decisions and their effects. To be more specific, it seems desirable that theories of educational finance take into consideration empirical knowledge about resource allocation at the micro level as well as the traditional concepts of public finance.[2]

We define policy decisions as those determinations made by the several branches of federal, state, and local government which are presumed to affect the behavior of members of educational organizations, including administrators, teachers, and students. Management decisions, on the other hand, are defined as choices which are made within the context of educational systems, and which affect the internal allocation of resources and the attainment of goals. Differences in the content of decisions are also perceived; policy decisions affect both the ends and means of education, but primarily the ends; management decisions, on the other hand, tend to be based on the selection of means for attaining a pre-determined set of objectives.

The three branches of the federal and state governments have been traditionally involved in policy decisions which influence the general directions of education. Congressional initiatives have emphasized the provision of financial support for special curricula such as vocational education, or specific categories of students such as the

economically disadvantaged, the bilingual, or the handicapped; state legislatures have attempted to increase equality of educational opportunity through the "reform" of methods of financing schools. Federal and state courts influence educational policy through their interpretation of the Constitution and of statutes; the executive branches of both levels of governments influcence policy both through the leadership provided by the chief executive officers and by government agencies and through the guidelines to legislation which are written and interpreted by members of the bureaucracy.

Within school systems the influence which superintendents, principals, and teachers have over the curriculum, is limited[3]; much of their effort involves allocating resources to meet pre-determined ends; decision makers in homes and classrooms may, however, exercise considerable leeway in establishing priorities and combining time with purchased resources. At times, the occupants of various roles may disagree on the weights to be attached to the various desired outcomes of education[4]; the existence of disagreement over the goals of education contributes to the difficulty of defining, let alone attaining, efficiency and equality in education.

Educational Efficiency and Equality

Our organizing principles consist of two criteria often used to illuminate analyses of public policy, namely efficiency and equality.[5] Efficiency is the relationship between the degree to which the objectives of education are attained and the amount of resources which are used. Equality refers to the variance in the benefits received by the recipients of educational services. These criteria are widely regarded as antithetical; an increase in efficiency may result in reduced equality, while the search for equality may require a sacrifice in efficiency.[6] It will be seen, however, that when decision making in education is viewed from the micro perspective the dichotomy between efficiency and equality becomes blurred.

Efficiency may be defined as the relationship between a set of specified results and the costs of attaining them*; in more concrete terms, efficiency implies either maximizing goal attainment within the constraints imposed by limited resources, or achieving a given set of goals at minimum cost.** Increases in efficiency are by definition desirable, since the outcomes of education are valued and since the resources used in educational systems, having alternative uses, are scarce.

In response to a widespread public perception that many educational systems are, in some sense, inefficient, a number of state and local education agencies have established so-called "accountability"

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*It is useful to distinguish between efficiency within educational systems and the efficiency of educational systems. The latter is measured by the relationship between the contribution of education to the national economy and the total costs of providing education. The former definition, used in this Report, implies comparing measured outcomes with costs within a specific system such as a school or a school district. We will use the terms efficiency and productivity interchangeably.

**A more detailed treatment of the definitional and measurement problems inherent in operationalizing the term efficiency is provided in Chapter 2.

procedures. While these procedures differ from one agency to another, their basic characteristics include attempts to measure results and costs, and to encourage behavior on the part of educators which would improve the outcome-cost relationship. In addition, some policy analysts have proposed utilizing the accountability incentives which prevail in the private sector of the economy, through the implementation of voucher systems.

The accountability and voucher approaches to improving educational productivity are alike in one respect; both regard the educational process as an unknown, and both rely on incentives or sanctions to bring about an improved relationship between outcomes and costs. Both have their origins in industry, where processes are known, and where, since outcomes are usually readily measured, performance incentives are relatively easy to apply. Proponants of accountability and voucher systems tend to ignore the importance and complexity of decisions made at the micro level by teachers, students, and parents.

The approach of some social scientists to the concern over educational efficiency has been to conduct "production function" or "input-output" research.* Like the proponants of accountability and voucher systems, these researchers regard the educational process as a mysterious "black box," and concentrate on studying the system's outcomes and inputs. Their goal--sometimes implicit and sometimes explicit--has been to provide a basis for improving rationality in decision-making by estimating the separate contributions to outcomes of a variety of variables, including characteristics of schools, homes, and communities; and thereby providing a basis for improved budgeting by ensuring that money is distributed among inputs so that the last dollar spent on one input has the same effect on student performance as the last dollar spent on every other input.

Apart from a variety of technical objections to be raised elsewhere in the Report, our main criticism of this line of research lies in its assumption that key resource allocation decisions are made centrally, and that a reallocation of resources at the school district level will have a predictable effect on productivity. The model dictates the use of aggregated data, thus concealing the effect of within-system differences in goals, resource allocation decisions, and technologies. Like the accountability and voucher approach, production function studies regard decisions made within classrooms and homes as lying within the mysterious "black box," which serves as a convenient container for a multitude of sins of scholarly omission.

In short, neither policy initiatives nor policy-related research provides the educator with an infallible guide for improving the efficiency of educational systems. This gap between the goals of public policy and its accomplishments remains wide when we turn to issues of equality in the distribution of the benefits of education.

While financial equalization among school districts may be desirable for a number of reasons, including equalizing the economic impact on communities of state financial support and removing unjustified inter-district differences in teachers' salaries, there is no evidence that fiscal equalization reduces variance in student achievement. However, if fiscal equalization does not result in improvements

*A more detailed analysis of the production function approach is provided in Chapter 3.

in achievement among the school districts where expenditure levels were formerly low, the major effect of the equalization of expenditure levels may be to diminish over-all efficiency of educational systems.

This gloomy prognosis is merely tentative. Our approach to the subject is to examine the relationship between resource flows at the macro level and the availability and use of resources by students within classrooms. Interestingly enough, the dichotomy between efficiency and equality becomes blurred at the micro level. If schools or homes are inefficient in producing learning for lower class students, efforts by state and federal policy makers to make educational systems more equitable may be frustrated. If, on the other hand, procedures are developed which improve the learning ability of lower class children, the educational system will gain both in efficiency and equality.

The "Production" of Education

We assume that education (or, to be more precise, learning) is, in a way, "produced" through a set of processes which utilize resources in order to bring about an improvement in students' cognitive and affective performance.* It is assumed that the manner in which resources are combined to produce learning in homes and classrooms is worth studying because (a) a better understanding of the conditions affecting resource allocation at the micro level is essential, if the effects of macro level policy are to be discerned; (b) both efficiency and equity are dependent on the possibilities which exist for varying the mix of purchased and unpurchased resources in homes and classrooms.

The differences between our approach and previous attempts to examine the relationship between educational inputs and outputs include (a) our emphasis on data which is disaggregated to the level of the individual student, teacher, and parent, (b) our systems approach which regards teachers, parents, and students, as well as administrators and legislators as decision makers, (c) our interest in the relationship among inputs as well as between inputs and outputs, (d) our inclusion of students' time as an input which is analogous to purchased inputs, and (e) our treatment of a variable which is largely ignored in the literature of school management and educational finance, as well as in production function studies, namely, educational technology.

Macro and micro level studies investigate different phenomena, and may therefore be expected to yield non-comparable findings. However, research findings which emanate from the analysis of data at one level have policy implications for the other. The failure of macro level research to uncover significant school effects has caused some researchers to examine the results of unequal allocations of resources within schools. Within school variance in outcomes may result from the unequal allocation of teachers' time to students in a given classroom, inequalities in peer characteristics as well as in purchased resources available to students in academic and non-academic tracks, and an unequal allocation of parents' time and other home resources to students in a given school. Hence, micro-level decisions affect results

*We have, arbitrarily, concentrated on the development of cognitive outcomes. This decision is reinforced by the likelihood that desired affective and cognitive goals are often joint products of instruction.

observable at the macro level, while the allocation of resources by state, federal, and local governments influences the educational environment to which students are exposed.

This analysis emphasizes the importance of utilizing a total systems framework in the analysis of decision making in educational organizations. While policy makers and administrators make resources available, teachers, parents, and students may be said to "produce" education since they decide how resources will be combined and used within homes and classrooms. School superintendents hire teachers with certain qualifications and behavioral predispositions, but these teachers subsequently determine, within bounds set by external constraints, the technological characteristics of their classrooms; they allocate their time and other resources among students; and they affect decision making by manipulating the costs and benefits which students perceive. Parents also help develop the capabilities of their children, both before and after the latter enroll in school. Micro level decisions made by teachers, parents, and students therefore have an important effect on both efficiency and equality.

Whatever level of analysis is used, much of the difficulty which confronts those who concern themselves with educational productivity lies in the specification of outcomes and costs. Most production function studies give some attention to the problem of specifying the former, while few provide a complete analysis of costs. However, specifying costs is at least as important and as difficult as specifying outcomes; glaring inadequacies result when the opportunity costs associated with the use of students' time are ignored.* Students contribute vastly differing amounts of their own time to education; in some cases, time is wasted, resulting in substantial losses in efficiency. It will also be noted that the "value" of students' time depends on the amount of human capital each student has accumulated. Inter-student differences in learning efficiency or accumulated human capital have implications for studies of school management, educational finance, and the production of learning.

Students' time and teachers' time are combined with physical resources to constitute sets of educational technologies; there are differences among classrooms in the complexity of the resulting technological mix. Since educational technologies form the essential link between macro level resource allocation decisions on the one hand and the characteristics of the production system on the other, a detailed examination of the determinants of technologies found in classrooms forms an important part of our work. A related phenomenon, treated only implicitly in prior research, is the degree to which one input may be substituted for another in the production of education; this phenomenon is obviously critical to the study of educational efficiency.

Finally, most of the so-called production function studies have been cross-sectional in nature; however, the production of education takes place over time. In particular, the ability of students to produce their own learning is to a considerable degree a function of prior

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*This point of view will be developed in Chapter 4.

investments made in their capabilities. Little attention is paid in the literature of school management and finance to the sequential nature of schooling; the application of human capital theory to education helps form the basis for a longitudinal approach to management decisions in education.

This Chapter has provided a brief introduction to the issues to be addressed in the Report. We now describe briefly how the remaining part of the Report will be organized.

Organization of the Report

The main body of the report will consist of five Chapters, including this Introduction. There is also an Appendix, containing a proposal for empirical work based on this analysis.

Chapter 2 deals with the definitional problems associated with the study of educational productivity and provides some examples of productivity indices which may be appropriate in the study of education. Chapter 3 reviews and criticizes the production function literature, and also discusses the relationship between production function studies and educational management.

Chapter 4 presents a theoretical analysis of resource flows within classrooms. In particular, the Chapter deals with the resource allocation decisions of teachers, parents, and students, and the interactions among these decisions. The Chapter's main theme is that micro-level decisions are dependent, to a considerable degree, on perceptions of the amount of human capital students have accumulated at a given point in time. This accumulation, which is largely based on prior investments of time and purchased resources, determines students' learning efficiency, which in turn affects the manner in which students' time is combined with other resources.

Resource combinations determine educational technologies, the topic of Chapter 5. The manner in which resources are combined is affected by the quantity and quality of the various inputs, as well as by the ease with which input substitution takes place. Existing micro-economic theory will be used as a procedure for developing testable hypotheses.

Appendix A presents a research proposal outlining the empirical work needed to test the hypotheses drawn from the conceptual framework of Chapters 4 and 5.

Footnotes to Chapter 1

1. For example, budget decisions made centrally affect the choices of educational technology available to teachers. Decisions made within homes and classrooms by parents, students, and teachers may frustrate accountability programs developed by administrators.

2. Since the beginning of the Century, educational finance has developed as a separate field of study, apart from public finance, but in recent years the literature in these fields has become more integrated, as public finance economists have become aware of issues in the financing of education. However, throughout this period, there has been a prevailing assumption that there is a one-to-one relationship between the quality of schooling and per pupil expenditures. We believe that this assumption needs to be re-examined, through the development of theory and empirical research which relates resource allocation decisions at the classroom level to macro-level decisions.

3. See Roald F. Campbell (1968) for a discussion of national influences on curricula.

4. For example, disagreements in resource allocation may arise if a teacher emphasizes social adjustment as the major educational goal, while a majority of parents place a higher weighting on the development of cognitive skills. The issue may be resolved by parents purchasing books, allocating their own time to their children's education, hiring tutors, or asking that the teacher be transferred.

5. For a discussion of the equity-efficiency quandary in higher education, see Theodore W. Schultz (1972).

6. Policy-makers may increase efficiency (in the short run) by allocating additional resources to high ability students, thus sacrificing equality in outcomes. In the long run, however, an investment in improving the efficiency of "slower" students may result in improvements in both efficiency and equality. (See Chapter 4.)

Chapter 2

PRODUCTIVITY IN EDUCATION: A MULTI-LEVEL ANALYSIS

Introduction

The term productivity* provides a general context within which issues of educational policy may be discussed. Productivity and equality are often regarded as antithetical, since an increase in productivity may lead to a sacrifice of equality and vice versa; economists therefore discuss the policy implications of trade-offs between equality and efficiency.[1] However, the policy proposals which follow from macro-level considerations of equity and efficiency may not always apply if educational systems are viewed from a micro perspective. By exploring this issue, we hope to contribute to the dialogue between educationists whose primary concern is the improvement of teaching and learning, and social scientists, who utilize statistical analysis to identify and explain causal relationships among variables.

Some scholars and practioners object to the application to education of the concept of efficiency[2]; however, the statement that schools (or other organizations) should become more productive is merely a tautology, because both aspects of productivity--increasing the attainment of valued goals, and conserving scarce resources--can be expected to contribute to the well-being of individuals and of society as a whole. Despite its tautological nature, the concept of productivity provides a unifying theme for both social scientists and students of management. For the former, it offers a context for comparing and contrasting a variety of studies which compare the benefits derived from an organization's activities with the costs of attaining them[3]; for the latter, it embraces and gives meaning to decisions which are related to goal attainment.[4]

Although the concept of productivity provides an indispensable basis for the analysis of policy, it suffers from vagueness and ambiguity; hence, a wide variety of often contradictory policies may, in the name of improving productivity, be endorsed. While it is neither possible nor desirable to obtain agreement on a single definition of the term, it is important that the definition issue be recognized, and that the ubiquitous problem of separating fact from value be kept in mind.

Defining Productivity in Education

There are two general approaches to defining the concept "productivity." The first is a working definition, useful as a basis for comparing alternative procedures. According to this definition, productivity is increased if costs are reduced without a corresponding reduction in the quantity or quality of the product; alternatively, productivity is increased if the quantity or quality of the product is improved without a proportional increase in cost. If we are interested in determining whether productivity is increasing or decreasing over time, or whether one educational system is more productive than another

*Throughout the Chapter, the concepts "productivity" and "efficiency" are regarded as being synonymous.

we require a "productivity index," consisting of a ratio of outcomes to costs. Before turning to the problems associated with developing such indices, we will discuss the two aspects of the simpler definition.

(1) Productivity and economy. A comparatively simple way to make school systems more efficient is to economize in the use of resources. Economies may entail using less expensive inputs (such as teachers with fewer years of experience) or changing the manner in which inputs are combined (for example, through increasing the size of classes). Whether or not economies result in an increase in productivity will, of course, depend on their effect on the quantity and quality of the educational product. The reduction or elimination of the use of unnecessary or redundant inputs (which are associated with waste) will, by definition, result in increased productivity.

(2) Productivity and improved outputs. Improvements in productivity may result from increases in the quantity or improvements in the quality of outputs, so long as these increases (or improvements) exceed in importance the added costs which are entailed. Until recently, there appears to have been a widespread belief that the benefits resulting from free secondary education, compulsary schooling, and subsidized higher education would always be greater than the costs of implementating these policies. There are strong indications that a limit may have been reached in the improvement of educational productivity through a quantitative expansion of the educational system; future productivity increases may depend on the enhancement of quality.[5]

While it might appear that increasing productivity by improving the quality of education would be a fruitful direction for educational policy, interpersonal agreement on the relative importance of the various aspects of "educational quality" is hard to obtain. One common definition of "quality" avoids the issue entirely; some observers merely equate quality with expenditure level, thus implying that productivity is constant.[6] This is a dubious approach which gives no useful guide for decision-making; a preferable method may be to assume agreement on a limited set of educational outcomes, and to identify ways (such as reallocating resources, motivating personnel and focusing the organization's direction) of maximizing the attainment of these goals.

Definitional problems are not peculiar to education; such problems are, however, probably more prevalent in the public than the private sector of the economy. Private firms utilize relatively unambiguous measures of costs and outcomes, although measurement problems result if social costs and benefits are included. Outcomes of public sector activities tend to be services rather than goods; since public enterprises seldom compete in the market place, it is difficult to assign a monetary value to their products. A widespread concern for improving productivity in the public sector results from the fact that this part of the economy has been expanding more rapidly than the private sector. In addition, as Levin pointed out, the costs of public services are increasing, and "there is a widespread belief that their quality is deteriorating. . . ."[7]

Early attempts to measure and improve productivity in education reached their height in the period from 1910 to 1929. Callahan (1962) described how educators, vulnerable to external pressures, adopted

procedures based on the so-called "scientific management" approach. According to Callahan, the major concern of those who attempted to apply the business ethic to education was on economizing rather than on improving educational quality.

> It is possible that if educators had sought "the finest product at lowest cost"--a dictum which is sometimes claimed to be a basic premise in American manufacturing--the results would not have been unfortunate. But the record shows that the emphasis was not at all on "producing the finest product" but on the "lowest cost." In all of the efforts which were made to demonstrate efficiency, it was not evidence of the excellence of the "product" which was presented, but data on per-pupil costs. This was so partly because of the difficulty of judging excellence but mostly because when school boards (and the American people generally) demanded efficiency they meant "lower costs."[8]

The definition of maximum productivity as "the finest product at the lowest cost" is intuitively appealing, but it is difficult to operationalize. It implies that both the objectives and the cost of an educational system can be analyzed into measurable components, and that the point of maximum productivity is reached when the ratio of performance to cost is as high as possible. However, educational systems have multiple objectives; some are complementary and others are competitive. Even within the cognitive realm, educators (often with the support of parents) may emphasize different objectives in different schools. Schools may spend substantial amounts of resources on the attainment of non-cognitive outcomes, thus limiting the resources available for cognitive achievement. Whether these decisions improve or inhibit productivity can only be determined on the basis of values assigned to specific outcomes by given sub-sets of educators, students, parents, and representatives of the larger society. Hence, judgments about educational productivity vary from community to community and even among families.

There are, of course, wide areas of agreement concerning the desired outcomes of education. There is a consensus that students should master the skills required for reading and computation; most people would probably agree that the outcomes of education should also include, for example, an understanding of the nation's governmental process and its economic system and the ability to obtain gainful employment. There is also widespread agreement concerning the importance of such non-cognitive outcomes as a respect for the law and for the rights of others, a preference for a governmental system which is based on widespread participation in decision-making, and an appreciation for works of artistic creation. However, differences persist both within and among educational systems in the priorities which are assigned to these objectives.[9]

While the difficulties which are inherent in obtaining a uniform definition of productivity are inevitable and unsurmountable, there are ways to simplify the problem, including distinguishing between definitions of productivity which are most appropriate at the various levels of decision-making.

Levels of Analysis

The productivity of educational systems can be examined at several levels. Studies conducted at the macro (state and national), sub-macro (school district), and micro (home and classroom) levels utilize different types of data and distinct analytic modes. Furthermore, the policy implications derived at the three levels differ in scope and may, at times, be contradictory. There has been little effort to reconcile these contradictions; hence, policies implemented as a result of macro or sub-macro analysis may not have the desired effect on teaching and learning within the classroom.

As the term implies, macro level studies utilize data collected for the nation as a whole, for major regions of the country, or for major population categories. Census data, student achievement test results, and statistics collected by national, state, and local education agencies provide the data base for these studies. Examples of macro-level studies include analyses of education's contribution to economic growth,[10] trends in the productivity of higher education[11] and rural-urban[12] and black-white[13] differences in returns to education. In their desire to base policy on research, members of the federal government (often requiring a greater demonstration of efficacy from educational programs than from other endeavors) have on occasion utilized these studies as a basis for supporting or opposing one or another type of national policy.

The hope that research into the relationship between the inputs and outputs of the nation's educational system would lead to improvements in either productivity or equity has been largely discredited.[14] Decisions concerning the selection of technologies, the choice of curricula, and the allocation of resources to individual students are made within school districts, and often within schools and even classrooms. Studies of resource allocation within and among school districts may therefore be more fruitful than macro-level studies in suggesting policies which will lead to improved productivity. Federal policy in education is, in other words, typically a necessary rather than a sufficient condition for improving educational productivity.*

Research studies at the school district level are often based on the assumption that schools and school districts are producers of educational achievement. These studies, which have been facilitated by the availability of school district census data, achievement test results, and improved financial and statistical data, have been designed to determine whether a reallocation of resources within school districts would result in improved productivity. This research, like macro-level analysis, has thus far provided no clear basis for the improvement of school district decision-making.

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*That is to say, many educational efforts, such as special programs for children from low income families, could not succeed without federal financing. Nevertheless, federal financing does not ensure their success.

The micro level of analysis examines decisions made by individual parents, students, and teachers. The assumption behind this focus of interest is that resources are allocated in homes and classrooms in response to individual perceptions of costs and benefits. While studies at the macro and sub macro levels have been conducted by economists, sociologists, and statisticians, the micro level of analysis is primarily the domain of the educationist, the psychologist, and the anthropologist.[15]

A balanced perspective must include all three levels of analysis. It is foolish to ignore decisions made at the micro level, because choices of parents, students, and teachers have a major effect on both productivity and equality of educational opportunity. On the other hand, decisions made at higher levels affect the alternatives available to micro-level decision-makers; decisions made by school board members and legislators affect the availability of resources and, in turn, the resource constraints which are faced by those who are most closely involved in the production of education.

This Chapter will discuss the topic of educational productivity from the macro point of view and Chapter 3 will examine studies of productivity at the school district level. Chapters 4 and 5 will develop the most neglected topic in educational management, namely, the involvement of teacher, students, and parents in the allocation of resources and the selection of technologies.

Productivity in Education: A Macro Perspective

In the United States, resources for the support of education are provided by all three levels of government, but many of the decisions concerning the selection of curricula and technologies and the allocation of resources are made by teachers, pupils, and parents. There is therefore a discontinuity between the way in which education is supported and the manner in which it is produced. It is largely for this reason that policy analysts have been frustrated by the inefficacy of state and local governments in dealing with the major issues of productivity and equality in education.

It is nonetheless instructive to examine these issues at the state and federal level. In the first place, education is a major factor in the ability of a nation to survive and prosper. Hence, educational productivity is, perforce, a national issue regardless of limits in the ability of the federal government to affect it. Second, while the states and the national government do not actually "produce" education, they make policies which affect decision-making at the micro level. In particular, by focussing on particular issues or categories of students, state and federal policy makers influence the priorities which are attached to the various possible outcomes of the educational system. Third, information about productivity which is of value to policy makers at all levels of government can best be obtained and analyzed at the national and state levels. These three aspects of the problem will now be discussed.

Productivity and National Policy

It is a truism that educational issues affect most if not all aspects of this country's well-being. The outcomes of the educational system influence such diverse activities as defense, agriculture, law enforcement, welfare, health, and civil rights. Since educational costs are massive (constituting in 1974 almost 100 billion dollars) and are increasing, a concern for productivity is inevitable.[16]

It is generally agreed that systems of formal education are essential for the survival of modern industrial societies. In addition, it would appear that nations which are aspiring to become modern must invest a portion of their resources in the establishment and maintenance of schools and colleges.[17] Education's contribution to industrial life includes screening, training, and channelling individuals into a wide range of vocations. The educational system also fosters attitudes which cause individuals to accept employment in a complex industrial society.[18] Because of the pervasive role of schooling in motivating individuals to accept employment and providing them with skills, it is not surprising that education has been viewed as a means for increasing a nation's rate of economic growth.

The "human capital revolution" in economics provides both a theoretical basis and an empirical methodology for the study of educational productivity.[19] Members of this school of thought view human capital as a produced good, which is both the output of educational systems and an input into the nation's economy. Like physical capital, human capital can depreciate and become obsolescent. The costs of producing human capital and the returns to its investment in the market place can be determined and subjected to cost-benefit analysis.

Until recently, studies of investments in education have indicated that our educational system is highly productive. Schultz concluded that:

> . . . the large rate of return on the total costs of education creates a strong presumption that more could be invested in education relative to other forms of investment to the advantage of economic growth.[20]

Denison found that, between 1929 and 1957, education contributed 42 percent of the rate of growth in national product per person employed.[21] Becker calculated rates of return to education which were higher than the rates obtainable from investments in the private sector of the economy.[22]

These findings were specific to the particular time period under study and the rate of return to an investment made in education by individuals or by society may be declining.[23] Table 2-1 summarizes research which suggests that the value of a college education for men has declined sharply since 1969.

Table 2-1

Changing Value of College Training for Men, 1959-74

Year	Internal Rate of Return (to nearest 1/2 percent) Social	Private
1959	10.5	11.0
1969	11.1	11.5
1972	9.5	10.5
1974	7.5	8.5

Source: Freeman (1975, p. 296)

The most obvious interpretation of economic cost-benefit studies in education is that schools and colleges produce skills which are exchanged in the market place for additional income. Some critics, however, claim that the apparent relationship between education and income results from the structure of society rather than from the content of the curriculum or the effectiveness of teaching. One possible conclusion is that the main function of schools is to screen the more able students from the less able; business firms find it easier and less expensive to hire individuals on the basis of the credentials that have been granted than to set up their own screening procedures.[24] Another possibility is that the amount of schooling an individual obtains and the income he subsequently receives are, to a considerable degree, determined by the social class of his parents.[25] In our society, social class and measured "ability" are closely related; an individual's ability affects both the amount of schooling he obtains and his subsequent income. Ability therefore affects the observed relationship between amount of schooling and earnings.[26]

Economic growth constitutes only one dimension of the so-called "social benefits" which have been attributed to education.* Others which have been mentioned include a taxation system based on the self-reporting of income, a publications industry which could not exist without universal literacy, and a government based on political democracy.[27] However, while most people agree that education produces social benefits, these benefits are elusive and difficult to measure; hence, the social benefits argument does not provide a precise guide to government fiscal policy with respect to education. It has been argued that the social benefits of education are less important than is frequently asserted by education interest groups, that the social benefits to education accrue

*Social benefits are defined as those benefits which are received by individuals other than the direct recipient of the service. The social benefits of education are received by members of the student's family as well as by his fellow employees, his future employers, and other members of the society.

mainly to primary rather than secondary and higher education, and that present levels of subsidization of higher education result in a redistribution of income from those in the lower income brackets to those who are able (by virtue of present income or anticipated future income) to pay for the educational services they receive.[29]

One way of avoiding these analytic problems is to define educational productivity at the macro level in terms of those objectives of education which the federal and state governments recognize (in legislation and administrative guidelines) as important. This assumption makes possible an examination of one aspect of the relationship between federal and state educational policy and educational productivity.

The Effect of National and State Policies on Educational Productivity

The educational policies of the federal government have, for many years, been directed toward improving the efficiency of the nation's schools and colleges. State policy has been focused on regulating educational systems, and providing them with a substantial portion of their operating funds, thereby partially equalizing the financial resources which are available to local school systems. It will later be argued that neither the federal government's attempts to improve educational productivity nor the states' policies designed to equalize opportunities can be adequately understood and evaluated without examining the manner in which resources are allocated at the micro level, that is, the level of the teacher, the child, and the parent.

The federal government's attempts to improve educational productivity take two forms. The first is the categorical grant strategy; national policy has been largely based on the assumption that if relatively small amounts of money are provided in such a way as to strengthen the educational system at its weakest points the system's total productivity will be improved. The second procedure consists of supporting attempts to improve educational productivity through research, dissemination, financial support of technological change, and the collection, analysis, and dissemination of data which may be used by decision makers.

One of the earliest and apparently most successful federal education programs was the establishment and maintenance, through the Morrill Acts, of the land grant colleges. The purpose of these Acts was to extend and improve higher education in the agricultural and industrial arts, thereby correcting what Congress believed to be the excessively academic emphasis of American universities in the first half of the Nineteenth Century. If even a modest portion of the increase in agricultural productivity which occurred subsequent to the Morrill Acts is attributed to Congressional action, the returns to the national investment were impressive.[29]

Another example of the use of categorical grants to improve the productivity of the national educational system is the Smith Hughes Act of 1917, and a long series of related laws, designed to enhance the quality of the nation's labor force through grants for secondary school

vocational education. These laws had an important effect on high school curricula; hence, taking Congressional priorities as an indicator of social benefits, they also affected the productivity of the nation's schools.[30]

The effect of the National Defense Education Act of 1958 was not quite as obvious as that of the Morrill and Smith-Hughes Acts. The ostensible purpose of NDEA was to strengthen the nation's defense posture by improving instruction in science, mathematics, and foreign language. The general purpose of the Act defies evaluation, and the specific purposes, while probably resulting in a shifting of priorities in the short run, were resisted by some educators, who resented the use of federal funds to influence curricular content.[31]

The most ambitious attempt by the federal government to improve educational productivity by means of categorical grants was the Elementary and Secondary Education Act of 1965. One innovation embodied in this Act was the use of federal funds to improve educational effectiveness for children from impoverished families. A secondary objective implicit in ESEA was attacking the poverty cycle itself. President Johnson stated:

> By this Act we bridge the gap between helplessness and hope for more than five million educationally deprived children. As the son of a tenant farmer, I know that education is the only valid passport from poverty.[32]

Accompanying ESEA was another set of programs, some with an educational component, which were offered through the Office of Educational Opportunity. Project Head Start, in particular, attempted to improve opportunities for children from poverty backgrounds by offering health and educational services to pre-school children.

While the purposes of previous categorical grant programs had often been vague and general, those of the poverty-related endeavors of the 1960's were more specific. It had been hoped that Project Head Start and Title I of ESEA would help equalize educational outcomes and, in the long run, contribute to the reduction of education-related poverty. In view of the over-ambitious objectives of Title I, it is not surprising that this effort to increase educational productivity has not been demonstrably successful. As a result of his examination of evaluations of Title I, Jencks (1972) concluded:

> The federal government has also made sporadic efforts to determine whether the "compensatory" programs established in 1965 under Title I of the Elementary and Secondary Education Acts were actually raising children's test scores. These evaluations are generally discouraging. The valuators usually had inadequate budgets, inadequate information, limited cooperation from the schools, and limited technical expertise. Nevertheless, if additional Title I funds were raising children's test scores by substantial amounts, the evaluations ought to show this more often than they show the opposite. In fact, the results of evaluations appear to be virtually random. Students in Title I programs do worse than comparison groups as often as they do better.[33]

An evaluation of Project Head Start conducted by the Westinghouse Corporation and Ohio State University resulted in the conclusion that "neither year-round nor summer Head Start programs had a significant long-term effect on children's cognitive growth."[34] While Jencks'

re-evaluation of the data resulted in the discovery that children from some centers retained an advantage over non-Head Start children throughout the first grade, he decided that "Overall, the evidence strongly suggested that Head Start's effect on children's cognitive growth had been quite transitory."[35]

To summarize, where national policy has been aimed at the achievement of broad, highly general goals, as in the case of the Morrill Acts, the effect on educational productivity (as defined by the apparent intent of Congress) was substantial. Where the objectives of federal programs are narrow and specific and where an evaluation of success was required (either in the law or in administrative guidelines), improved productivity has not been demonstrated. This disappointing finding can be explained in part by the discontinuity between federal planning and the micro level production of education. We hope that this manuscript will contribute to an increased awareness of the importance of the interrelationships among decisions made at the macro (state and national), sub macro (school district), and micro levels of the educational system.

Another type of contribution by the federal government to the improvement of educational productivity has been the support of research, the provision of assistance in the development and utilization of new technologies, and the dissemination of knowledge about successful practices. While measures of the efficacy of these efforts cannot be readily obtained, the cost is small in relation to total educational expenditures, and the potential benefits to decision-makers of possessing additional knowledge and having access to technological alternatives is substantial. There are also economies of scale when research and dissemination are financed and sponsored by the federal government rather than by states and local school districts.

Productivity, Equality, and State Government

Although the responsibility for ensuring that educational systems are established rests with the states, it is only in recent years that state governments have evinced an interest in the productivity of these systems. Traditionally, the role of the state has been to provide a legal framework within which local school districts, which are legally "arms of the state," can provide educational services.[36] The states' role has been largely a regulative one; states have established minimum standards, together with enforcement mechanisms to ensure that these standards are met. All states have also developed systems of financial support whereby the state revenue system is used to supplement local property tax receipts.[37]

Despite the important constitutional role of the state, educational programs provided by elementary-secondary public school systems have been to a considerable degree locally financed, and the quality of these programs as well as the tax effort required to support them has depended on the wealth of the local district. State "equalization" programs, which resulted in more state dollars per pupil being provided to less affluent than to more-affluent districts have only partially compensated for inter-district differences in property values.[38] Because of the large expenditure differences among districts within most

states, and because local wealth has tended to be positively related to expenditure levels and negatively related to tax rates, reformers have concentrated on the states' role in equalizing educational opportunity.

Following the seminal work of Wise[39] and Coons[40] which dealt with the constitutional issues associated with inequalities in the financial support of education, individuals in several states brought suit, basing their case for equalizing the financial support of education on either state or federal constitutions. The Serrano case, which was based on the California Constitution, established the principal of fiscal neutrality, which means that local expenditures must be independent of local taxpaying ability.[41] Although the Supreme Court decided, in Rodriguez, that there is no federal constitutional issue in the manner in which education is financed in the United States, state courts in a number of states have followed the lead of California, with the result that many efforts have been initiated or are under way toward equalizing educational finance.[42]

While the concepts of equality and efficiency have been regarded as independent and possibly antithetical they are interrelated, especially in issues of educational finance. Reforming educational finance implies committing additional money to education, since a mere redistribution of existing revenues would not be politically feasible. Unless the additional revenues result in an improvement of educational quality in the school districts which benefit from the new procedures, an over-all decline in educational productivity will, by definition, result. Moynihan predicted that the "new" money would be utilized to pay higher salaries to currently employed teachers, thus probably lowering productivity.

> Teachers will benefit. Any increase in school expenditure will in the first instance accrue to teachers, who receive about 68 per cent of the operating expenditures of elementary and secondary schools. That these are estimable and deserving persons none should doubt, but neither should there be any illusion that they are deprived. . . . In general, they are deservedly well-paid professionals.[43]

In an empirical test of Moynihan's proposition, Kirst examined the budgets of 23 school districts in the Los Angeles area which had received a 15 percent increase in funds in a single year as a result of school finance reform. He found that although teachers' salaries had increased, the percent of the total budget wpent on teachers' salaries had actually declined, while there were significant increases in the percent of the budget allocated for instructional aides and textbooks. In fact, despite the large increase in available resources, teachers' salaries in low wealth unified school districts increased at a rate which was less than the average increase for the state.[44]

This analysis demonstrates the need for additional studies of the effect of macro-level policies on the production of education at the micro level. This need was also indicated by the decision of the New Jersey State Supreme Court in Robinson v. Cahill.[45] The plaintiffs in this case made two arguments. The plaintiffs in this case made two arguments. The first was that the equal protection clauses of the

United States and New Jersey Constitutions prohibited the state "from discriminating in favor of children attending public schools in wealthy school districts by distributing the State's educational resources in proportion to the wealth of the respective school districts." This theory of fiscal neutrality was accompanied by a second argument, that New Jersey's constitution's "thorough and efficient" education clause required the state to afford each child "at least such instruction as is necessary to fit it for the ordinary duties of citizenship" and "to provide the minimum education to all children . . . so that they may be able to read, write and function in a political environment."[46]

Tractenberg (1974, pp. 32,33) summarized the court's ruling:

> The legislative and executive branches have begun the complex process of responding to the court's mandate of a new school finance law for New Jersey. Their response must be shaped to reflect the following constitutional guidelines which the court articulated: (1) the state must spell out "the content of the educational opportunity the Constitution requires"; (2) the state must ensure that the required educational opportunity is provided equally to all children in the state; (3) the state must provide a mechanism by which the educational opportunity being afforded can be assessed; and (4) the state must ensure that appropriate corrective action is taken if it appears that certain school districts are not providing the required educational opportunity.[47]

Thus, unlike other state court decisions which have merely mandated a reform in educational finance, the New Jersey Law has accompanied this requirement with the stipulation that the legislature must introduce an "accountability" system. Accountability means different things to different people, and there are three possible interpretations to state accountability laws.[48] The weakest interpretation is that it implies providing information to people in a state about how well students are performing in basic school subjects. A stronger interpretation is that the state's responsibility includes not only assessment but also some form of "quality control." One form this control is taking in some places is the requirement that in order to graduate from high school, students must demonstrate at least minimum competence in essential curricular areas. The strongest interpretation of "accountability" is that corrective action must be taken in school districts where required performance standards are not met. This requirement, which appears implicit in the Robinson decision, reinforces the conclusion that the effectiveness of decisions taken at the macro level is dependent, to a large degree, on an improved understanding of the linkage between the macro (policy) and the micro (production) levels in education.

One function which is best performed at the macro level is the gathering and analysis of data. These data can be used in the study of productivity trends in education.

Productivity Indices in Education

An index of productivity consists of a measure of the product which is obtained from a unit of input--money, labor, or material.

A productivity index in the steel industry, for example, may consist of the number of tons of steel which are produced, on the average, by each unit of labor.[49] In education, a number of different indices may be defined, depending on how outputs and inputs are conceptualized and measured. One relatively precise index of educational productivity consists of the ratio of the number of students who receive a given amount of schooling to the total educational expenditures in the same period of time.

Table 2-2 illustrates this type of productivity index. Column (1) whows the total expenditures (in current dollars) for public elementary and secondary education in the United States, at ten-year intervals. Column (2) expresses these figures as a percent of the Gross National Product. The first "index," which is presented in Column (3), shows the per pupil cost over this time period. Column (4), which expresses per pupil costs in constant dollar terms, is a better index of educational productivity than Column (3), since it is corrected for the effect of inflation. It is readily apparent that costs increased substantially from 1940 to 1970--per pupil expenditures at the latter date were over three times as much as those at the earlier date. Does this mean that educational productivity has dropped sharply since 1940? The answer is "Yes," unless the increased costs in 1970 are associated with an improvement in educational quality. Whether the quality of education has improved, remained constant, or declined during this time period is, of course, difficult to demonstrate, because it is as difficult to define "quality" as to define "productivity."

Table 2-2

Expenditures for Public Elementary and Secondary Education: 1940-70

Year	(1) Total: Current Expenditures and Interest (billions)	(2) Elementary and Secondary School Expenditures (Public and Private) As a Percent of GNP	(3) Total Per Pupil Expenditures in Public Elem. & Sec. Day Schools Current $	(4) Column (3) Expressed in Constant (1970) Dollars
1940	$2.106	3.5	106	286
1950	4.869	3.4	259	413
1960	12.951	5.1	472	607
1970	35.900	7.5	970	970
Ratio $\frac{1970}{1940}$	17.0	2.1	9.2	3.4

Sources: U.S. Department of Commerce, Bureau of the Census, Statistical Abstracts, 1973, p. 107, Table 160 and p. 119, Table 183.

A common measure of industrial productivity is output (however measured) per man-hour. A comparable index of educational productivity is the ratio of students taught to teachers employed. This simple measure is readily calculated from basic educational statistics, and

can be used to measure changes over time, or to make comparisons among educational organizations. Table 2-3 shows the pupil-teacher ratios for public elementary and secondary schools in the United States at five-year intervals from 1955 through 1970, together with projections through 1984.

Table 2-3

Public Elementary and Secondary Day Schools: Pupil Teacher Ratios
United States, 1955-1974 and Projections through 1984

Year	Organizational Type	
	Elementary Schools	Secondary Schools
1955	30.2	20.9
1960	28.4	21.7
1965	27.6	20.8
1970	24.3	19.8
1975 OProjected)	22.4	18.6
1980	21.0	17.9
1984	20.1	17.5

Sources: 1955 and 1960 data, U.S. Department of Commerce, Bureau of the Census, Statistical Abstracts, 1973, p.d. 124, Table 193. Subsequent data Projections of Educational Statistics to 1984-85. (Washington: U.S. Department of Health, Education, and Welfare. Education Division, 1976), p. 62, Table 28.

Two interesting findings emerge from Table 2-3. In the first place, staffing ratios have been decreasing in both elementary and secondary schools. In the second place, the ratios have declined much more at the elementary than the secondary level, to the point where the two ratios become almost identical.

One possible interpretation of Table 2-3, is that educational productivity has declined since 1955. This conclusion is inevitable, if the definition of "productivity" offered in the Fleischmann Report is accepted.

> "Productivity" as we use the term relates to the number of certified personnel required to serve, on the average, any fixed number of students. A gain in productivity occurs when the number of professional staff required to serve that fixed number of students is reduced with no loss on the part of students.[50]

The Commission then recommended that:

> The state should seek to increase the ratio of students to adult instructional personnel (teachers and teaching paraprofessionals) in classrooms throughout the state. The present ratio of 20 to 1 should be gradually raised to 22 to 1. Currently, class size in New York is low; in fact, it is the lowest of any industrialized state. A majority of research studies on student performances reveal that modest

changes in class size have negligible effects on normal students. However, considerable cost savings could be realized by slight increases in state-wide class size.[51]

These conclusions and the Commission's recommendation are, of course, anathema to teachers' groups, who tend to take the position that small classes constitute an important aspect of educational quality. This assumption is frequently dismissed as self-serving, since a reduction in class size makes the teacher's role easier, and since a low pupil-teacher ratio improves employment prospects for teachers, a consideration which is especially important during a period of decreasing demand for teachers' services.

However, the possible negative relationship between class size and educational quality cannot be readily dismissed. In the first place, one factor which has led to a reduction in the pupil-teacher ratio has been the increased availability throughout the nation of programs in vocational and special education, two areas in which small classes are usually considered, for both pedagogical and safety reasons, to be desirable. (Table 2-4) One might speculate that these data are symptomatic of a general trend toward adapting class size to curricular goals. In the second place, decisions concerning class size should not be based solely on studies which fail to show a relationship between this variable and scores on tests of cognitive achievement, since small classes may exert a greater affect on important affective outcomes of education. Affluent communities appear to be willing to spend money raised from the local tax base in order to send their children to schools with small classes, and well-to-do parents pay substantial tuition fees to educate their children in private schools which emphasize their low student-teacher ratio. In other words, when the consumers of educational services can afford the cost, they will often pay additional money to purchase small class instruction.

Table 2-4

Exceptional Children Enrolled in Special Programs

1948-1971
(Thousands)

Type	Year			
	1947-48 School Year	1958 (Feb)	1963 (Feb)	1970-71 School Year
Total	378	890	1,682	3,158
Visually & Aurally Handicapped	21	32	68	102
Speech Impaired	182	490	802	1,237
Emotionally & Socially Maladjusted	15	29	80	113
Mentally Retarded	87	223	432	830
Other Handicapped	51	64	87	395
Gifted	21	52	215	481

Source: U.S. Department of Commerce, Bureau of the Census, Statistical Abstracts, 1974, p. 115, Table 184.

It is impossible, for these reasons, to evaluate the class size recommendations presented in the Fleischmann Report. Large and small classes constitute only one dimension of a larger issue, namely, the selection of technologies which are appropriate for specific aspects of a curriculum, and for specific categories of students. While the costs which class size represents constitute an important aspect of decision making at the macro level, problems of interaction between student characteristics and technologies can best be examined at the micro level.

State and national data therefore tend to support the hypothesis that educational productivity has been declining. Further evidence for this point of view was presented by Woodhall and Blaug (1968), who studied the productivity of British secondary schools for the period from 1948 to 1963. They used three measures of output, an economic index (the present value of average lifetime earnings of each group of school leavers), a length of schooling index, and an academic index. For each output index, they found that, "after all adjustments, there remains a residual fall in productivity between 1950 and 1963 of over one percent per annum. Each year more resources are needed to educate each school child." They concluded:

> This study has shown that the inputs required to produce one school leaver have risen steadily since 1950; there have, at the same time, been a number of increases in the quality of education provided in secondary schools, whether measured in terms of the lengthening of school life, examination results, or enhanced lifetime earnings prospects, but none of these improvements in quality matches the increased costs of education. By our definition, productivity has declined between 1950 and 1963 at a rate of one to two percent a year. This is in direct contrast to the performance of other sectors of the economy; the productivity of manufacturing and service industries has risen by one or two percent a year.[52]

Additional evidence that educational productivity may be declining is provided by the trend in achievement test scores over the past decade. In a comprehensive study of this phenomenon, Harnischfeger and Wiley found that "The reported test score declines are more dramatic in recent years, and most evident for higher grades. They are especially pronounced in verbal tests, but hold for nearly all tested areas."[53] The authors found that the decline cannot be attributed merely to changes in the content or the scaling of the tests, or to changes in the composition of the group taking the test.

In evaluating the importance of these findings, it is necessary to point out that the period during which test scores declined was also one in which educational costs (in constant dollars) continued to increase. Any reservations about the importance of these findings must therefore rest with either (a) the nature of the measured outputs; or (b) possible out-of-school environmental influences which may have had a negative affect on achievement. While achievement test results do not measure the entire range of desired outcomes of schooling, few would argue that they are without value. On the other hand, since learning takes place in many contexts, a decline in educational effectiveness of

non-school environments (such as might result from an increase in television-watching) could constitute a partial explanation for the above findings.[55]

While productivity trends can best be observed in data collected at the national or state level, there are limitations in the ability of federal and state governments to improve educational productivity. In fact, poorly conceived legislation which increases costs without affecting educational outcomes may contribute to the decline in educational productivity. In other words, federal support for educational programs may, as noted above, be often a necessary but seldom a sufficient condition for improving the efficiency of educational systems. To obtain a better understanding of the sufficient conditions, we turn in the next chapter to a consideration of the concept of productivity as viewed from the school district perspective.

Footnotes to Chapter 2

1. For a discussion of some of these issues as they affect higher education, see Schultz (1972, pp. S2-S30).
2. This concern is placed in historical perspective by Callahan (1962).
3. One weakness in policy-oriented research in education is that recommendations which involve changes in resource allocation are sometimes made in the absence of an explicit measure of their cost.
4. The implementation of PPBES, for example, is motivated by a desire to increase the productivity of educational systems.
5. Denison (1962, pp. 76-77) concluded that "What is needed to prevent the contribution of education to (economic) growth from falling very sharply before the end of this century is a great acceleration in the rate of increase in quality."
6. A recurring issue in educational finance is whether the level of educational expenditures is reflected in the quality of an educational system. One reason why this cost-quality relationship has not been empirically proved or disproved is, of course, that there is no single definition of educational "quality." In a system which is marked by decentralized decision-making, local residents may, presumably, make simultaneous decisions concerning the services which will be provided and the financing which will be obtained through local revenue sources. The cost-quality relationship is then tautological, since quality simply reflects the types of expenditures which are made. Mort and Reusser (1951, p. 117) stated: "Today it can be said with considerable assurance that communities spending more for education get more of what promises results desired by people in general." This approach assumes that high expenditure educational systems are those in which both ends and means differ from those in low expenditure areas. Thus, high expenditures may result in additional programs (such as those in art and music) as well as in improved methods of achieving a given set of objectives (such as are made possible by small classes and well qualified teachers.)

If we think of quality in terms of consumption as well as investment, there are many advantages in attending high expenditure schools. They may be safer, more attractive, cleaner, and conducive

to good physical and mental health. In addition, schools which provide a diversified program, including training in areas such as art, music, and vocational subjects are sometimes defined as offering a high quality of education. If the term "quality" is defined as standing for the level of mastery of so-called basic subjects, there is no evidence that high expenditure has an effect on achievement which is above and beyond the influence of the home. From their analysis of a variety of studies, Jencks (1972, p. 93) concluded:

> The evidence we have examined does not suggest that doubling expenditures would raise students' performance on standardized tests. A school's annual expenditure is, it is true, moderately related to the test scores of its alumni. But this is because affluent schools enroll students whose test scores are above average to begin with.

The absence of a clearly defined relationship between expenditures and a universally accepted index of educational quality poses serious problems for policy making at the level of the school district. The implications are particularly complex in the field of educational finance--a subject to which we will return in Chapter 6. Efforts to "equalize educational opportunity" through the redistribution of financial resources rest upon a concept of educational quality which is vague and which lacks an empirical foundation.

The assumption that expenditure level is identical with educational quality provides an inadequate set of guidelines for the educational manager. The message which he receives is "work in your community and at the state level to obtain additional funds, since the extra money will by definition result in improved education." This conclusion was probably accepted by a large proportion of school administrators in the 1950's and 1960's, when expanding budgets were the rule rather than the exception. In the 1970's, on the other hand, inflation, taxpayer resistance to school levies, and declining enrollment have changed the environment within which administrators perform their function. In most school districts the amount of discretionary funds (or funds which are still available after providing for negotiated increases in salaries) is under pressure. Hence, administrators often seek to develop a rational basis for allocating scarce resources. Some of the problems which face those who attempt to provide such a basis for administrative decision-making at the school district level will be discussed in Chapter 3.

7. Henry M. Levin (1974, p. 3).
8. Callahan (1962, p. 244).
9. For an empirical study of differing perceptions of educational goals, see Downey (1960).
10. See, for example, Denison (1962). Also, Schultz (1961, pp. 46-48).
11. Freeman (1975, p. 296).
12. Welch (1966).
13. Welch (1973, pp. 893-907).
14. "It is known that socioeconomic factors bear a strong relation to academic achievement. When these factors are statistically controlled, however, it appears that differences among schools account for only a small fraction of differences in pupil achievement." Coleman (1966, pp. 21-22).

15. Cusick (1973). However, economists are increasingly using disaggregated data in studies of educational productivity. For example, see Summers and Wolfe (1975) and Murnane (1975).
16. Total public and private expenditures for education at all levels in 1974 was estimated at $96.3 billion. Statistical Abstracts of the United States, 1974. (U. S. Department of Commerce, Bureau of the Census, 1974, Table 174, p. 110.)
17. Harbison and Myers (1964).
18. Bowles and Gintis (1976, p. 11) write "The educational system . . . is best understood as an institution which serves to perpetuate the social relationships of economic life . . . by facilitating a smooth integration of youth into the labor force."
19. Bowman (1966, pp. 115-116).
20. Schultz (1961, p. 84).
21. Denison (1962, p. 73).
22. Becker (1964).
23. Freeman (1975, 1976).
24. See, for example, Wales (1973, pp. 28-55); and Layard and Psacharopoulos (1974, pp. 985-998).
25. This argument is developed by Samuel Bowles and Herbert Gintis (1976, p. 31).
26. See Taubman and Wales (1973), and Hause (1972, pp. S108-S138).
27. For a summary view of issues concerning the social benefits of education, see B. A. Weisbrod (1964).
28. Windham (1976).
29. Bowman (1962, pp. 523-546).
30. A number of cost-benefit studies of vocational education have been conducted, including that of Corazzini (1968).
31. For an analysis of NDEA, see Kratzmann (1963, pp. 57-72).
32. Quoted by Tiedt (1966, p. 192).
33. Jencks et al (1972, p. 94).
34. Jencks (1972, p. 86).
35. Jencks (1972, p. 86).
36. For a discussion of the constitutional role of the states in education, see Edwards (1933, Chapter II).
37. See Campbell, Cunningham, Nystrand, and Usdan (1975, Chapter Three).
38. James (1961).
39. Wise (1967).
40. Coons, Clune, and Sugarman (1970).
41. Serrano v. Priest, 5 Cal. 3d 584, 487 P.2d 1241, 96 Cal. Rptr. 601 (1971).
42. San Antonio Independent School District v. Rodriguez, 411 U.S. 1 (1973).
43. Moynihan (1972, p. 71).
44. Kirst (1976).
45. Robinson v. Cahill, 62 N.J. 473, 303A 2d 273 (1973).
46. Tractenberg (1974, Chapter I, pp. 16-17).
47. Tractenberg (1974, pp. 32-33).
48. Campbell, p. 51.
49. For a discussion of productivity indices, see Salter (1966).

50. The Fleischmann Report (1972, Volume III, p. 173).
51. The Fleischmann Report (1972, p. 174).
52. Woodhall and Blaug (1968, pp. 1-35).
53. Harnischfeger and Wiley (1975).

Chapter 3

EDUCATIONAL PRODUCTIVITY: THE SCHOOL DISTRICT PERSPECTIVE

Introduction

Decisions made by centralized authorities can be implemented uniformly, while policy initiatives taken by local school districts tend to be diverse with respect to both ends and means. When there is consensus concerning national needs, the federal government can develop policies which are designed to have a uniform effect throughout the country; states can attempt to equalize educational opportunity by making equal amounts of money available for education for all districts, regardless of the local tax base.

However, the efficacy of federal and state efforts in actually bringing about improved productivity and greater equality is limited, since most of the decisions which affect these goals are made within school districts, where elected and appointed officials are charged with responsibility for providing educational services. Educational administrators and local school boards define and assign priorities to the objectives their districts will pursue; they procure financial resources and allocate time and money through the processes of budgeting, hiring and firing and assigning personnel; and they evaluate the results of their efforts. I therefore discuss in this chapter approaches to management and research which focus on decisions made by school district officials.

In analyzing educational efficiency and equality at the school district level, we consider three distinct but related sets of variables. The first set comprises the outcomes or products of educational systems; these outputs may be conceptualized in several ways. Educators and their clients may consider their educational systems to be service-producing agencies; in these terms, productivity is dependent on the cost and quality of the services which are provided, while inter-district inequalities may be defined in terms of variety and quality of services which are produced by school districts. Many citizens and legislators now desire to evaluate educational systems in terms not only of the services they provide, but also of the changes in student performance which result from these services. From this point of view, productivity is a measure of the relationship between average student achievement and average cost, while inequalities among districts are measured by the inter-district variance in average student achievement.[1]

A second set of variables includes the socio-economic characteristics of school districts, usually defined in terms of the districts' occupational distribution, educational characteristics, and income level. These variables affect both the ends and means of educational systems. Their effect on objectives is partially revealed by

an examination of the relationship between parental social class and students' curricular choices. A study by Warner, Havighurst and Loeb suggested that "the social class of a pupil and his family have considerable influence on the choice of a high school curriculum."[2] Recent research, more broadly based than the early case studies, suggests that parental social class affects students' curricular placement both directly and indirectly through the influence of social class on students' ability.[3] Equally important is the well-demonstrated relationship between districts' average social class and average student achievement.[4] The social class of a district also affects the system's inputs, including the characteristics of professional employees, the curriculum, and the technologies which are employed.[5]

A third set of variables reflects decisions made by administrators and school board members who, by means of the budgetary process, allocate resources in a manner which has relevance to the attainment of their systems' goals. Also, through their hiring and firing policies, their supervision of personnel, their designing of school buildings, purchasing of equipment, and control over maintenance and operation of buildings, they affect the environment within which instruction takes place. Educational managers select an organizational structure which appears to be appropriate, in view of the size of the educational system, its objectives, and the socio-economic status of its community. Administrative decisions set limits on the types of technologies which may be used. All these types of decisions may affect educational productivity.

Rationality and Administrative Decision-Making in Education

There are several perspectives upon which an understanding of administrative decision in education may be based. Well established in the literature of educational administration is the socio-psychological view, which regards educational organizations as social systems within which behavior can be explained by the interaction between the institutional dimension and the personal characteristics of teachers, administrators, students, and others.[6] Somewhat related is the political perspective, which is concerned with the effect on decision-making of pressures exerted by individuals and groups both within and external to the educational system.[7] The third perspective is the "rational" or economic view; educational administrators may be regarded as maximizers, not of profit, but of a set of objectives which may be regarded as indicators of the economic outcomes of education.

The economic perspective does not rest on the assumption that school administrators and school board members consciously attempt to maximize the attainment of a given set of objectives. It is sufficient to take the position that they behave, on the average, as if this were their intent. The economic view is therefore an idealized version of behavior which may be compared with actual decisions and their consequences.

The model assumes that the management sub-system of educational organizations has the responsibility for (a) defining objectives; (b) determining appropriate procedures or means for achieving these

ends; (c) assessing the degree to which these procedures are effective; and (d) using the results of the evaluation to re-consider both ends and means. However, attempts to formalize management procedures on the basis of this model have not been completely successful, probably because of a lack of understanding of the complexity of educational systems, whose objectives vary, both among and within schools and school districts. Furthermore, while the rational model is based on the assumption that procedures are selected so as to maximize the attainment of pre-determined goals, in actual practice ends and means interact, so that a district's objectives may depend in part on the amount of resources it has at its disposal. (Wealthy districts offer courses in the fine arts, while less wealthy districts may confine themselves to the "basics.") Finally, as noted above, both the ends and means of educational systems are affected by its socio-economic environment; the social class of a community may affect a school system's objectives, its success in meeting these objectives, and the types of inputs it utilizes.

School superintendents make decisions about objectives and procedures in many contexts, and usually in an incremental manner.[8] Decisions to build a vocational school, to add a course in auto mechanics or in Spanish, or to hire a high school teacher of developmental reading all involve adding to the system's objectives. When resources decline, school systems may increase class size, or they may eliminate courses in areas which are considered to be of only marginal importance; these decisions involve either the use of less expensive methods or a decrease in the total set of objectives. The advantages of the incremental approach are that it is easier to assess the costs and benefits of marginal decisions than to attempt to evaluate a full set of objectives simultaneously, and that incremental decision-making makes it possible to take political realities into account on a decision-by-decision basis. On the other hand, because of institutional inertia, incrementalism may lead to the persistence of outmoded goals and procedures.

The interaction between means and ends in education, and the complexity of educational objectives preclude an easy acceptance of the proposition that while values influence the choice of objectives, the methods for achieving these objectives are determined through a process of rational decision-making. It is nevertheless instructive to develop a decision model which is based on the assumption that objectives are pre-determined.

According to this model, rational administrators will (a) exert their influence so as to increase the amount of resources at their disposal, and (b) allocate available resources among inputs in such a way as to maximize goal attainment. The first portion of this proposition explains the behavior of school superintendents and school board members who use political means to increase total revenues from local, state, and federal sources.

The essence of the rational model lies in the second part of the above proposition. The decision-maker is faced with two types of "givens," first, a set of objectives, stated in measurable terms, and

second, a set of constraints. The constraints may be of several types, including the total amount of resources which are available, the inputs which have already been obtained (including tenured teachers, school buildings, and equipment), and also the characteristics of the adult population and the student body. Within the limitations imposed by all these factors, administrators will allocate money among the inputs so as to attain the best possible level of performance.

The political environment within which decisions must be made is probably more important in determining the educational budget than is the implementation of the rational model. In addition to the ubiquitous political factors, there is also the problem that only a weak linkage exists in education between resource allocation and predicted outcomes; neither increases in expenditure, reductions in class size, reallocations of resources among inputs, nor new types of technologies has a predictable effect on educational outcomes.

The evaluation of results is therefore an essential aspect of rational decision-making in education; while it is not possible to manipulate causal factors in a manner which will invariably bring about the desired results, decision-makers can measure the effects of decisions, and can utilize a variety of procedures in an attempt to reduce the difference between actual and desired outcomes. Furthermore, evaluation is an essential aspect of accountability systems by which individuals are held responsible for attaining a desired level of performance. Some agencies therefore appear to regard the terms evaluation and accountability as synonymous.

One problem which results from this emphasis on evaluation in educational management is that test scores tend to become ends in themselves, rather than comprising a body of information which is used to bring about improvements in organization and instruction. Furthermore, evaluation efforts tend to focus on a narrow band of outcomes, especially those which are relatively easy to identify and measure; accountability systems may therefore produce an instructional program which overemphasizes measurable achievement.

Management Systems in Education

Management systems such as PPBES (program-planning-budgeting-evaluation systems) or MBO (management by objectives) are designed to routinize the implementation of the rational model of administrative decision-making in education.[9] When they are wisely used, these systems require administrators and school boards to base decisions on information, and to make choices on the basis of explicit criteria; they permit communities to participate in formulating educational objectives, and, through their representatives, to attempt to select the best methods of attaining them.

Unfortunately, the availability of information does not guarantee a rational approach to decision-making. While the PPBES model is based on the assumption that educational procedures will be selected through an analysis of costs and effectiveness, the results of implementing specific procedures in educational systems are uncertain; fur-

thermore, certain costs, in particular the opportunity cost associated with students' time, are ignored.* Some systems use statistical cause-effect models as a basis for making decisions; however, because of the probabilistic nature of statistical models, the results of implementing a given procedure can only be estimated; furthermore, while the procedure may indeed be effective in bringing about improved performance for some students, it may not have the desired effect in the case of students who differ, in their approach to learning, from the modal individual.

In short, there is no evidence that the introduction of formal management systems by school districts has resulted in improved performance. In fact, educational managers are probably sceptical about the efficacy of systems which assume that important decisions affecting student performance are made centrally. At any rate one case study of two school districts which claimed to have adopted PPBES found that the actual implementation was only superficial, and that decisions were affected by political pressures.[10]

Mention should be made at this point of an entirely different approach to the development of management systems for schools and school districts. This approach focuses on decisions made in the classroom, rather than at the level of the school district. The main purpose of these systems is to facilitate the individualization of instruction, through the use of sets of diagnostic and instructional materials. The role of administrative components of these systems is to provide support for the instructional subsystem.[11]

This micro approach to the development of management systems seems to this author to hold considerable promise. However, some observers argue that there is at present little incentive for the managers of educational systems to improve the productivity of the organization they administer. Those who take this position advocate a different mechanism for improving educational productivity, namely, the use of vouchers to permit parents to choose from among a variety of educational systems.

Educational Voucher Systems and Alternative Schools

The use of voucher systems as a basis for enhancing productivity through a restructuring of educational finance has been endorsed by individuals who are characterized by a wide range of philosophical backgrounds, from the politically and economically conservative analysts of educational issues to the more liberal.[12] Their proposals are based on the apparent belief that if parents were permitted to make a choice among schools for their children, educational systems would become more productive and also more responsive to their clients. The hypothesized effects of voucher systems on productivity and organizational responsiveness represent two different phenomena, and therefore need to be analyzed separately.

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*This issue is explored in Chapter 4.

The productivity argument rests on an analogy with the private sector, where firms are believed to become more productive because of pressures resulting from the profit motive. Companies will, it is assumed, select combinations of inputs and utilize technologies which will enable them to produce a given product at the lowest possible price, or, alternatively, to produce an improved product at a given price. Educational systems are believed to be inefficient because there are few incentives for educational managers to identify and adopt the best known practices; if managers were forced to compete for their clientele, they would be more likely to search for methods to improve productivity.

This argument seems to be based on the assumption that educational organizations are designed to produce a specific product or set of products, such as scores on tests of educational achievement. Under competitive conditions, school systems would use more effective technologies, so that average test scores would increase, while there would be a tendency to keep costs as low as possible. Parents would shop around until they found a school which provided an effective education within the limits dictated by the sum of the amount of the voucher and the supplemental funds they were able to provide.

Whether this is a realistic prediction cannot be determined without additional evidence, because experiments in voucher systems for elementary and secondary education in the United States have been limited in scope.[13] There is, however, a different argument for voucher systems, namely that this method of financing education would result in schools which would be responsive to the needs and desires of their clients; the schools would therefore adapt ends as well as means to client demands. This argument assumes that productivity is defined differently by different families.

Increased responsiveness to parental demands has been sought in public as well as private schools, without the use of vouchers, through the so-called "alternative schools." These schools are designed to provide parents with a choice of both goals and methods of reaching the goals, thus making the total educational system more adaptive to the varied requirements of members of a pluralistic society. Whether these schools would be more productive than existing institutions will depend on one's definition of objectives. Even if they do not result in an increase in traditional measures of outcome such as the average present value of future income or average scores on achievement tests, they may result in improved welfare if the latter term includes the ability of individuals to pursue goals (for example, in the humanities and fine arts) which have psychic rather than economic value.

These issues pervade all attempts to examine the productivity of educational systems. Despite these problems, well-designed studies of the relationship between decisions made by school managers on the one hand, and educational outcomes on the other, have considerable value. However, the complexities of the issues, as well as the dangers which may result from basing policy recommendations on research findings are not always recognized. One issue area in which the last caveat is not always made explicit involves studies of the optimal size of educational organizations.

The Size of Schools and School Districts

Educators have for many years favored the reorganization of small school districts into larger administrative units, and the consolidation of small schools into schools of greater enrollment. These efforts have resulted in a reduction of the number of school districts in the United States from over 100 thousand in 1945-46 to fewer than 17 thousand today. Increased school size is especially evident at the elementary level; from 1960 to 1973, the number of public elementary schools in the United States decreased from over 90 thousand to about 65 thousand. Much of this decline reflects the closing of one-teacher schools, the number of which decreased from almost 150 thousand in 1929-30 to about 2 thousand in the Fall of 1970.[14] Like many important phenomena, the increase in the average size of educational organizations in the United States is subject to various types of explanation.

A political interpretation of the forces leading to an increase in size of educational systems, especially in the cities, is that while the ostensible purposes of centralizing urban school systems were to provide uniformity of curriculum and instruction, to eliminate interference in school matters by non-professionals, and to emulate the organizational efficiency which was supposedly characteristic of large business corporations, the underlying cause was a desire by professionals and members of the upper classes to wrest control of the schools from residents of local communities.[15] The term "reform" has therefore changed in meaning over the years; at the turn of the century, it was used to stand for centralization of authority, the creation of large administrative units, control by professionals, and the depoliticizing of the schools; modern reformers, on the other hand, call for decentralized control, especially, of course, in the cities, increased political involvement in educational issues by members of the general public, and a decrease in professional autonomy. One outcome of the new reform movement in education has been the creation of smaller administrative units, notably the local sub-districts within the New York City school system.[16]

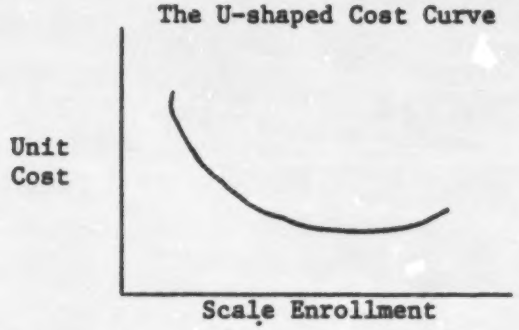
A less controversial aspect of the issue of organizational scale in education is the desire expressed by clients and legislators that schools provide a broader range of services than can be offered economically in systems of small enrollment. Rural school consolidation has been rationalized in terms of the demand by students, parents, and policy makers at the state and national level that rural students be provided courses in such fields as vocational agriculture, homemaking, and industrial arts. Large suburban high schools often attempt to respond to the demands of a highly diversified clientele by offering a wide spectrum of academic and vocational courses, many of which are more expensive than courses taught in the basic academic curriculum. Hence, the economies which might otherwise result from increased scale are offset, in whole or in part, by a wider, more diverse, and more costly mix of service outputs.[17]

The economic approach to issues of school district or school size involves the concept of economies of scale. This concept, borrowed

from industry, is based on data suggesting that unit costs often decline with an increase in the scale of the production system. In some cases, unit costs increase again as production exceeds a certain level.[18] Figure 3-1 is a graphic presentation of the concept. It should be remembered that this graph is based on theories which are drawn from industry and are not necessarily applicable to education.

Figure 3-1

The U-shaped Cost Curve



There are two main reasons why a productive process may be characterized by economies of scale. In the first place, there are some costs which are present in all organizations, regardless of size; in larger organizations, these costs are spread over a larger quantity of outputs, so that unit costs will decrease. For example, laws in some states require that school districts must hire a full-time school superintendent; in larger districts the costs per pupil of paying a superintendent's salary tend to be greater than in small districts; studies of educational costs indicate that, on the average, per pupil costs for administrative services decrease as total enrollment increases.[19] The other reason for the existence of economies of scale is that increased organizational size makes possible a greater degree of specialization among personnel; assembly lines in the automobile industry are typical of the economies obtained by rationalizing the productive process through identifying specific tasks and assigning each to an individual with specialized training and responsibility. In education, larger school districts are characterized by functional specialization, with specially trained individuals assigned to specific administrative and guidance roles.[20] Within the role of teacher, specialization takes place on the basis of subject area or grade level, and is associated with the teacher's competence, preferences, and training.

Several studies have attempted to identify the relationship between the size of schools or school districts and per pupil costs. For example, Cohn (1968) studied the effect of scale in Iowa's high school districts, and concluded that "an increase in enrollment of one pupil would reduce per pupil cost by approximately $.17 when enrollment is 100, but that per pupil costs would increase by nearly $.04 when another pupil is added to a school in which 2,000 students are

already enrolled. Intuitively, it is obvious that the optimal school size is somewhere between 100 and 2,000. . . . In the Iowa case, optimal school size is found to be 1,653 (pupils in ADA)."[21] Katzman reported several studies, including his own, in which an enrollment of 2,000 appears to be optimal.[22]

These findings are likely to be influential in policy-making circles, since they address an issue which has relevance for an important objective, economizing without reducing educational quality. However, the application of the economy of scale argument to education is not as simple as may appear because neither outputs nor costs can be readily conceptualized, defined in operational terms, or measured. Making decisions about the size of schools or school districts on the basis of the relationship between monetary costs and enrollment is not appropriate since certain aspects of educational quality are associated with size; in particular, the nature of the service mix produced by educational organizations is related to their total enrollment. This phenomenon may strengthen the case for increasing the scale of secondary schools, since larger schools tend to offer a wider variety of services, including more expensive courses in technical and vocational subjects. Studies of the relationship between cost and scale should deal explicitly with this issue, so that the cost curve will be based on comparable outputs. A more complex issue concerns the omission in these studies of non-monetary costs, in particular the opportunity costs associated with the use of students' time. In a subsequent chapter, we will argue that these aspects of cost are not trivial, and that they have a direct bearing on issues connected with organizational size in education.

A study by Barker and Gump, which indicated that students participate more intensively in extracurricular activities in small schools than in large schools, has implications for both outputs and costs. It suggests that there may be non-cognitive benefits associated with attendance in small schools which are not always present in large educational systems. A second implication of their study is that students' time may be used more intensively in small high schools than in large schools.[23] This raises the possibility that, if the total costs of instruction (including money costs and opportunity costs) were taken into consideration, the economies of scale which researchers have "found" may be illusary.

In summary, while the issues related to the optimal scale of educational organizations are of paramount importance, they cannot be resolved solely on the basis of the relationship between enrollment and monetary costs per pupil. Furthermore, the effect of scale on educational quality raises some complex issues; larger schools and colleges can provide a greater variety of services than can smaller organizations; however, the effect of enrollment on the cognitive and affective outcomes of education has not been adequately explored.

The issues involved in considering the best size for school districts and the best size of schools have not always been sufficiently distinguished from each other. Certain types of services may be produced by school districts (and, in some cases, by intermediate dis-

tricts); special education and vocational education, for example, may be provided by regional authorities. For the most part, however, education is "produced" within individual schools, where enrollment affects the social structure and the socio-psychological environment within which learning takes place. In large high schools, a considerable proportion of the time of students and teachers may be devoted to administrative matters,[24] and substantial sums of money are required to ensure the safety of students and teachers. Finally, technological advances, including the use of new types of inputs such as computer terminals and television may in time counteract the curricular and instructional rationale for the existence of relatively large schools.[25]

The problems which arise when we use statistical studies to determine the optimal size of educational systems are similar to the problems which are raised by studies of school effects on achievement. The latter studies represent sophisticated attempts to determine relationships which may potentially be of great value to decision-makers. I therefore turn now to an examination of this category of research.

School System Productivity Studies

As a society we place considerable faith in the solution of social problems through research. Private firms in particular use substantial amounts of resources for research into new products and technologies; many companies have found that such investment leads to improved productivity and therefore higher profits. In education, research has traditionally focussed on such issues as the nature of the learning process, the social organization of the classroom, and the relative effectiveness of various instructional procedures.[26] In recent years, however, social scientists have also conducted research which, if successful, would result in improved decision-making by those responsible for educational management; better decisions would, in turn, lead to improved productivity and possibly greater equality in the distribution of the benefits derived from education. Many of these studies have used the school district or the school as the unit of analysis.

"Production Function" Research

Some economists with interests in education have conducted statistical studies which are designed to determine the relationships between those variables which can be influenced by educational administrators and the outcomes of educational systems. They employ the technical term "production function," previously used to describe economic input-output studies at both macro and micro levels, to categorize their educational studies. The reader is reminded that the word "function" is employed in a mathematical sense to describe a statistical relationship, rather than in its more familiar sociological usage.

These studies are based on the assumption that school districts are analogous to business firms; administrators and school board members make decisions which are designed to maximize the attainment of

educational objectives in the same way that managers of business firms attempt to maximize profits. The purpose of the research is therefore to identify variables under the control of administrators which will lead to improved student performance. Since production function studies are often based on broadly representative samples, researchers have been hopeful that their work would lead to improved productivity throughout the entire educational system.

These studies have been made possible by the availability of large, diverse and probably reliable banks of data which are comparable among school districts and often across states. Unlike business firms, which guard their information jealously, school districts must furnish substantial amounts of statistical materials to governmental agencies. Furthermore, because of pressures for accountability, more and more states and school districts provide the general public with results of achievement tests, aggregated to the school district (and sometimes the school) level. Comprehensive research studies such as Project TALENT and the Equality of Educational Opportunity study make available to researchers a variety of types of information about schools, students, and school districts.[27] Census data have now been aggregated to the school district level and are available to researchers and policy makers.

One major task for the researcher who wishes to use such data to identify cause-effect relationships is to develop appropriate theoretical models. The model used by economists is especially relevant to students of educational management, because it is based on decision theory; the key assumption which this model embodies is that the rational manager will allocate the resources at his disposal so as to maximize goal attainment. He will do this by selecting inputs so that the last dollar spent on one input, for example, teachers, will bring the same results as the last dollar spent on other inputs--books, motion picture projectors, and so on.

The theory which underlies statistical input-output studies reflects in important respects the seminal research of earlier sociologists such as Warner, Hollingshead, and Havighurst.[28] Consider, for example, the manner in which social class concepts are used to explain the relationship between school-related variables and the performance of students. The earlier studies demonstrated the effect of social class on students' aspirations and teachers' attitudes toward students, thus partially explaining how schools tend to perpetuate the existing social structure, while allowing exceptional students to arise above the status of their parents. Other studies have shown that the social class of the community helps determine the nature of the curriculum and the kinds of inputs which are included in an instructional program. A major remaining challenge is to use statistical procedures such as multiple regression or path coefficients to illuminate the independent effects of schooling on student performance.

One difference between the earlier sociological studies and modern analyses of the effects of schooling lies in the manner in which data are pooled or aggregated. While the classic studies of social stratification depended on data aggregation, they were, for the

most part, confined to a single community; they made substantial use of descriptive material to relate their findings to the experiences of their readers. High speed computers have made possible the analysis of larger amounts of data, possibly at the sacrifice of an intuitive "feel" for the nature of the relationships which are uncovered; furthermore, the use in statistical studies of aggregated data conceals the complexities of the responses of individuals to their environment, and, in particular, the manner in which educational systems affect students with specific backgrounds, abilities, and motivations. There is therefore a discontinuity between the proclivity of educators to look for individual differences in learning modes and the tendency of social scientists to search for "school effects" which will influence mean characteristics of entire categories of students in predictable ways.

Before we turn to an examination of several so-called input-output studies, we should consider two important issues which relate to students rather than schools. The first issue deals with the measure of students' performance which the studies are designed to explain; the second deals with the "entry characteristics" of students, or those characteristics which are present at the outset of the educational experience, and which help determine success or failure. The most commonly used measure of student achievement is the score on a standardized test; this measure has several advantages. Economists are interested in the degree to which test scores predict future income and students' access to the job market; educators and their clients use test scores as predictors of continuation in school and future academic success. However, test scores measure only a narrow range of all possible objectives of schooling, emphasizing cognitive outcomes, and often ignoring the affective consequences of education. Educational systems are like multi-product firms; objectives vary among and within schools; studies which assume that different schools are attempting to maximize the same outcomes are misleading; using the results of these studies as a basis for modifying educational policy may be harmful to those categories of students to whom the results do not apply.

Researchers have not not reached consensus on the best way to define and operationalize the concept of ability, or to use it in statistical input-output studies. One difficulty is that ability has been, to a degree, produced by investments made within the home and the school; hence, if ability and achievement are included as independent and dependent variables, respectively, in a regression equation, the results will be distorted because the variables measure two aspects of the same phenomenon. One solution is to use longitudinal rather than cross-sectional analysis; the dependent variable is then a measure of "value added," or change in level of performance, and one independent variable, which represents both "native ability" and prior investment, can be the student's performance in the given subject at the outset of the time period.[29]

I recommend that the reader examine several of the production function studies listed in the bibliography, as the best method of

understanding the rationale and methodology of this type of research. For those whose interests in the subject are more casual, there are several summaries of the input-output study literature.[30] In the remainder of this chapter, I will discuss some important economic and sociological studies, and some questions which are raised by this type of research.

Several economists have used data gathered within a single large urban school system rather than national or state-wide data in attempts to determine the nature of the relationships between inputs and outputs.[31] This approach has several advantages; for example, there is a greater likelihood that the data will be comparable across sub-units when a single district is used than when comparisons are made across school districts. Furthermore, researchers who study a single school system can, with the assistance of school officials, utilize a wider array of information than those whose studies encompass a number of districts. One drawback to confining one's research to a single school system is that the results may be of limited generalizability; for example, findings which result from studying the Chicago school system may not be relevant to Boston, New York, or Los Angeles.

This section discusses two studies, one carried out in Boston, and the other in Philadelphia.[32] Both works are good examples of economic theory and methodology applied to education. They differ sufficiently in their approach to provide useful insights into this area of research through a comparison of methodologies and findings.

Katzman's investigation consisted of a statistical analysis of data gathered from the fifty-six school districts in the Boston Elementary School system. Each of the districts contained up to five schools; however, the observations consisted of averages computed for the district as a whole; no attempt was made to deal with the effect of schooling inputs on individual schools or on specific categories of students. The study was cross-sectional in nature; that is, the data were gathered for a single point in time.*

Katzman's statistical model was based on the assumption that the outcomes of Boston's elementary school districts are dependent on two types of "input" variables, namely, the resources provided through the educational systems and the characteristics of students' environment which affect their learning. Since the learning situation provided by the home and the community cannot be easily changed by the efforts of educators, the researcher focused his attention on the effect of the school.

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*One of Katzman's measures of performance is the <u>difference</u> in median reading scores between the district's second and sixth grades. This formulation of output does not qualify the study to be longitudinal, because, since both medians were obtained at the same point in time, the two grades contained two separate populations of students.

Each set of relationships between school effects, background influences, and schooling outcomes is written as an algebraic equation called a production function. Since Katzman identified six measures of school outputs, he constructed the same number of production functions. The output measures were: (a) the rate of average daily attendance; (b) the rate of continuation of elementary school graduates through high school; (c) differences in median reading scores between a district's second and sixth graders; (d) median level of mathematical competence among fifth graders; (e) percentage of sixth graders in a district who take the Latin School examination; (f) percentage of sixth graders passing the Latin School examination. His models do not necessarily rest on the assumption that these six outputs represent the variables which administrators attempt to maximize. Rather they are "proxies" for some underlying values which educators and their constituents think are of importance. For example, the percent of sixth graders who take the Latin School examination is believed by the researcher to be an indicator of students' aspirations to attend college.

Differences in the home background of students affect their aspirations and attainment as well as their decisions to attend regularly. In order to account for the effects of home and community, Katzman aggregated 1960 Census data for each school district. From a statistical viewpoint, the socio-economic variables "control" for the effects of home and community, and assist the researcher to estimate the actual effect of school variables.

The final set of variables consists of those resources of personnel, space, and materials which school district decision-makers made available for the instructional process. According to the decision theory described earlier in this chapter, administrators and school boards will allocate among inputs the total amount of money which are available to them in such a way as to maximize the attainment of desired objectives. The purpose of production function research is to attempt to identify the contribution which each type of input makes, per dollar of cost, to the various output variables. In Katzman's research, the following variables were included in the school resource category: expenditure per student, expenditure per classroom, pupil-teacher ratio, teacher turnover, and several "teacher quality" variables, including the percent of teachers who are accredited, the percent of teachers with a master's degree or beyond, and the percent of teachers with over ten years' experience.

The statistical procedures used by economists in their production function studies is called multiple regression; this method identifies the separate effect of each predictor variable on the output variable, when other factors are subject to statistical controls. On the basis of this procedure, Katzman found that (a) there is no evidence that simply spending more money will improve performance; (b) spending money to decrease class size is apparently not effective within the range of sixteen to thirty-five students; (c) spending money to reduce overcrowding has a positive effect; (d) spending money to hire more accredited and more experienced teachers is effective, while spending more money to hire teachers with more training is ineffective.[33]

Katzman's statistical model of the effect of background variables and school resources on outcomes, therefore, is an analogue of the decision model which views the task of school district administrators as allocating money among purchases of goods and services so as to maximize goal attainment. Katzman sees production function research as providing assistance to school administrators who, unfortunately, "have only the vaguest knowledge of the educational production functions."[34]

This disparaging view of educational administrators may not be warranted, especially as there is widespread criticism, in the literature, of the theoretical and methodological bases of production function research.[35] One type of criticism is especially relevant at this point; important decisions about the allocation of resources are made by teachers, students, and parents, as well as administrators, and research such as Katzman's, which is based on aggregated data, conceals the complexity of the interaction between school inputs and individual students. A meaningful analysis of issues related to educational productivity therefore requires that studies conducted at the school district level be supplemented by a more micro type of analysis.

One of the most provocative studies of educational production was conducted by two economists at the Philadelphia Federal Reserve Bank, Anita A. Summers and Barbara L. Wolfe (1975). They obtained data from pupil files for 627 sixth grade elementary school students, 553 eighth grade junior high school students, and 716 twelfth grade senior high school students. A two or three year school history was compiled for each student, which was matched with data on school-wide resources of the school attended, income data, and data on each student's individual teachers. The dependent variable was a change in a composite achievement test score over a two or three year period.

Summers and Wolfe were able to use this data to examine their main thesis, that:

> the reason educational studies have failed to find that the things schools do are effective, is that there are few things which are consistently effective for all students.[36]

Their major effort was, therefore, to look for interactions between school inputs and type of pupil. This search was successful, since they found that "for many school resources, the effect on some types of students is very different--and, frequently, in the opposite direction from the effect on other types of students."[37] This suggests first, that schools do indeed have an effect on student performance and second, if the nature of the input-student interaction were better known, it would be possible to improve productivity by implementing policies suggested by research. Let us first examine some of the findings of the study and then turn to its implications for educational management.

Among their more interesting findings were that, in elementary schools, students who were achieving below grade level benefited from being in classes with less than 28 students, while students who were achieving at grade level and above could, without negative effect, be in classes of 33. They found that black elementary school students benefit particularly from being in smaller schools, and that high

school lower achievers also benefit from small school size. Similarly, teacher experience has a differential effect, depending on student characteristics: in elementary schools, high-achieving students do best with more experienced teachers, while low-achieving students do best with relatively inexperienced teachers. Peer group effects are also complex: elementary school students who test at grade level or lower are helped by being in a school with more high-achieving students, while students performing above their grade level are not particularly affected.

This intriguing research raises some important issues. The researchers recognized that their study requires replication before the results become definitive. Even if the findings are substantiated, educational managers must still proceed with caution, since there may be negative effects on some students of implementing a procedure which has a general positive effect. There is a more general issue which arises from this research, namely, that issues of resource allocation may touch on but do not incorporate questions of learning theory. It is important to ask why small schools benefit black elementary school pupils, why relatively inexperienced teachers benefit low-achieving students, and why peer group effects are different according to students' grade levels.

There are several ways of interpreting the implications of this research for educational management. On the one hand, managers and policy analysts who are oriented toward centralized decision-making may look for ways for central office personnel to implement the procedures which might be inferred from the research. For example, school boards and superintendents might move toward decreasing class size for low-achieving students and increasing class size for those who are achieving at grade level or higher. However, the results of statistical studies are not intended to be implemented in this fashion; even if the over-all effects of the change were good, some students might gain and others might lose in the process; the best which research of this type can do is provide hypotheses for further research and for the tentative implementation, on a small scale, of the findings, with a careful assessment of results preceding more large-scale change.

The findings of this study might, however, be interpreted in a different manner. The conclusions that the effects of school resources differ among categories of students, that the effects of inputs are not always linear, and that interactions among input variables have important effects on educational outcomes all suggest that cause-effect relationships in education may be more complex than many researchers had anticipated. Indeed, the complexity of educational systems may surpass the ability of centralized decision-makers to gather, store, and utilize the vast amounts of information required in order that inputs and technologies may be matched with the characteristics of individual learners. This possibility is reinforced by the belief that the value of unpurchased inputs, in particular, the time of teachers, students and parents, constitute a hitherto forgotten element in the production process. It therefore seems highly likely that only those who are close to the learning process can manipulate the rela-

tionships between inputs and outputs in such a way as to substantially affect educational productivity.

Before turning, in Part III, to a discussion of some aspects of decision-making at the micro level, we wish to consider the contributions of sociologists who, like economists, are increasingly interested in the importance of resource allocation within educational systems. The interests of sociologists and economists have converged, in recent years, as both have utilized similar models in attempts to determine the nature of school effects on learning, and discussions following the publication of the Coleman Report on Equality of Educational Opportunity (1966) were characterized by considerable interdisciplinary interaction.[39] However, there are some essential differences between the approaches taken in these two disciplines. The economic approach is more clearly normative, since it is directly related to decision theory. Sociologists make more use of process variables (such as peer group effects), deal more explicitly with socio-psychological influences on learning, and are interested in the manner in which organizational structures mediate between background effects, inputs, and outcomes.[40] Furthermore, some sociologists utilize statistical procedures such as path analysis which have the capability of identifying complex causal patterns.

As one possible explanation for these disappointing findings resulting from the Coleman Report, Heyns suggested that "The general conclusion that resources do not determine achievement differentials between school ignores stratification patterns and access to resources within schools and necessarily understates the effects of such resources."[41] One systematic method of allocating resources differentially among students is through their assignment to tracks or curricula. Heyns pointed out that there are differences among high school curricula in the resources made available to students: "If access to better teachers, counselling, and highly motivated, academically oriented peers affects achievement to any degree, such resources should operate between curricula within schools as well."[42]

Alexander and McDill studied the factors which lead to curricular placement, and the effects of such placement on academic achievement and on three non-cognitive outcomes of schooling--intellectualism, self-conceptions of academic competence, and educational plans. Access to the college preparatory track was found to depend on both ability and social class. Those who had the good fortune to be placed in the college preparatory track had the advantage of resources not available to other students, and they tended to do better than anticipated, on the basis of their ability, in tests of academic competence. Curriculum placement also exerted an upward bias, in the case of the college preparatory curriculum, on the non-cognitive outcomes of education which are listed above.[43]

This research supports the hypotheses that there are substantial differences among categories of students in the manner in which educational resources are allocated within schools, and that these differences have an effect on the outcomes of schooling. The within-school variation in achievement which Coleman and his colleagues

observed may therefore be due, to a considerable degree, to school-related factors. The research of Heyns and of Alexander and McDill therefore converges with that of Summers and Wolfe; all agree that within-school variables may provide insights which are not available to those who work with highly aggregated data.

Controversies over educational policy have been characterized by unwarranted optimism and irrational pessimism. Optimism was prevalent in the mid-1960's, when the educational programs of the New Frontier were held out as universal solutions for inequality and inefficiency in education. Some remnants of faith in our ability to affect educational efficiency and equality persist, notably among those who would solve the problems through a reform of the procedures whereby education is financed. Researchers who have sought to use input-output analysis to provide a basis for improving educational productivity have also contributed to the hope that these problems could be solved through policies implemented at the state or school district level.

It would now appear that those among us who held these expectations were over sanguine, possible because the manner in which resources affect students is too complex to permit productivity to be improved through centralized decisions, or to allow meaningful research based on data gathered and aggregated on a broad basis. Some scholars, rather than turning to a more precise analytic method, have assumed that the failures listed above imply that schools have little or no effect on learning. Jencks, for example, presented the following pessimistic conclusion:

> As long as egalitarians assume that public policy cannot contribute to economic equality directly but must proceed by ingenious manipulations of marginal institutions like the schools, progress will remain glacial.[44]

It is, however, a large and unwarranted step to move from a disappointment with the results of macro models of decision-making and research to Jencks' eventual conclusion, that the only way to improve equity is through the development of a socialist economy.

The middle ground between these two extremes is to develop models of education production which recognize the importance of interactions among inputs and between inputs and outputs at the level of the child, the teacher, and the parent. We therefore turn, in Part III, to an analysis of the problem at the most <u>micro</u> level.

Footnotes to Chapter 3

1. For a further discussion of alternative ways of looking at schools as productive organizations, see Thomas (1971, Chapter 2).
2. Warner, Havighurst, and Lobb (1944, p.).
3. Alexander and McDill (1976).
4. Thomas (1962).
5. Thomas (1968, Chapter 2).
6. Getzels, Lipham, and Campbell (1968).
7. For example, Peterson (1976).
8. Braybrooke and Lindblom define an incremental change as "a some-

what greater or reduced use of an existing social technique or a somewhat higher or lower level of attainment of existing value . . ." Braybrooke and Lindblom (1963, p. 64). A well known example of incremental decision-making in education is the manner in which the school budget is constructed. The customary practice is to start from last year's budget and make adjustments in it, rather than to start with a clean slate.

9. For a comprehensive discussion of PPBES, see Hartley (1968).
10. Van Geel (1973).
11. One example of this approach is IGE (Individually Guided Education) which was developed by the University of Wisconsin's Center for Cognitive Learning.
12. See, on the one hand, Friedman's classic discussion of the voucher issue (1962). On the other hand, see Jencks (1966).
13. Levin (1973).
14. National Center for Education Statistics (1976, p. 22).
15. Tyack (1974).
16. See, for example, Zimet (1973).
17. Thomas (1971, pp. 45-55).
18. Very large scale may lead to diseconomies because of the additional costs of maintaining a large administrative structure.
19. School Management magazine, "Cost of Education Index."
20. Thomas (1968, Chapter 2).
21. Cohn (1968, pp. 422-34).
22. Martin T. Katzman, The Political Economy of Urban Schools (Cambridge, Mass.: Harvard University Press, 1971), pp. 88-89.
23. Barker and Gump (1964).
24. See Cusick (1973).
25. Wilson (1970).
26. Travers (1973).
27. Flanagan et al. (1964). Coleman et al. (1966).
28. Warner, Havighurst, and Loeb (1944).
29. For a discussion of "entry level characteristics," see Bloom (1962). Garner (1973) demonstrated the use of production function research in which the dependent variable is a measure of "value added."
30. See, for example, Averch et al. (1972).
31. For example, Burkhead, Fox, and Holland (1967); Katzman (1971); Summers and Wolfe (1975).
32. Katzman (1971); Summers and Wolfe (1975).
33. Katzman (1971, pp. 72-74).
34. Katzman (1971, p. 78).
35. For a good critique of production function research in education, see Garner (1973, pp. 21-25).
36. Summers and Wolfe (1975).
37. Summers and Wolfe (1975, p. 7).
38. Summers and Wolfe (1975, p. 8).
39. See, for example, Bowles and Levin (1968, pp. 3-24), and (1968, pp. 393-401). Coleman (1968, pp. 237-246); Mosteller and Moynihan (1972).
40. Bidwell and Kasarda (1975, pp. 55-70).

41. Heyns (1974, pp. 1434-1451).
42. Heyns (1974, p. 1425).
43. Alexander and McDill (1976).
44. Christopher Jencks et al., Inequality (New York: Basic Books, 1972), p. 265.

Chapter 4

RESOURCE ALLOCATION WITHIN EDUCATIONAL SYSTEMS

Introduction

Organizations such as schools, school districts, or colleges whose purpose is to provide educative services constitute complex decision-making systems. An important category of decisions made in these and other organizations comprises the allocation of money and the resources of land, labor and materials which money purchases. Such decisions include (a) the allocation of money among educational systems and (b) the use of money within such systems to purchase those resources which are necessary for the production of learning. A third type of decision, largely ignored in the educational management and finance literature, includes the allocation of both students' time and purchased resources in the classroom and the home.

Since these decisions are interrelated, no one level of management can properly be studied in isolation. The money which is made available to schools, school districts and colleges by federal, state and local governments sets limits on the amount and kind of buildings which may be constructed, teachers who may be hired, and equipment and books which may be purchased; these limitations or constraints affect the decision options which are available to teachers and students. The budgetary decisions of school districts are affected by the total amount of money available. These decisions set limits on the resource combinations which are possible at the micro level. Decisions made in the classrooms and homes are constrained by resource availability; they determine the learning environment; and they affect the implementation of decisions which are made at higher levels.

Decision-makers in educational organizations therefore include teachers, students, and parents, as well as administrators, school board members and legislators, and the decisions which are made by each member of the organization affect the decisions of others who occupy the same or different roles.[1] All members of the system are involved in allocating resources. For example, superintendents oversee the construction of the budget; principals assign teachers to classrooms; teachers allocate their time and other resources to students; students allocate their own time to the learning process; parents allocate their time as well as space and other resources to the development of their children's learning skills and store of knowledge.

Despite its immense complexity, the system is not, we assume, a random one. The traditional reason for assuming non-randomness is that all members of social systems are affected, in their decision-making activities, by institutional norms and role expectations. A second reason for assuming non-randomness in decision-making is that, if organizational members are considered to be rational decision-makers, each of whom is attempting to optimize the attainment of his or her own set of priorities, the resulting behavior will still be patterned, because the decisions made by each individual constitute opportunities or constraints for each other person in the organization.

Many analysts, who emphasize the social systems approach, argue that the members of educational systems cannot realistically be assumed to be attempting to maximize the attainment of a given set of outcomes. For example, while the belief that the superintendent's role is to allocate resources so as to obtain the highest possible level of student achievement, is implicit in arguments for accountability as well as in production function studies[2] it seems probable that he is likely to behave so as to ensure political and financial support for the school system and for himself.[3] Teachers are interested in job satisfaction, as well as in student achievement.[4] The goals which students set for themselves and the methods they employ to reach them are heavily affected by the values of their peer group.[5] In short, behavior within educational organizations is influenced by the nature of the social system and in particular by the informal relationships which are developed within it.

Without denying the efficacy of the social systems approach, we will also maintain that members of educational organizations behave in systematic ways, which can be interpreted within a rational decision-making framework. We will hypothesize that: (1) there are predictable differences in resource configurations among classrooms which serve communities with different socio-economic backgrounds; (2) within classrooms and among homes in a given community, there are predictable differences in the supply of resources to students and in the amount of time supplied by students and their parents to the learning process; (3) the key variable in explaining the effects predicted in the first two propositions is the value which is assigned to students' time.

The next section of this Chapter will deal with the qualitative and quantitative aspects of students' time in education. The section will be followed by a consideration of the manner in which students' time is combined with other resources.

Students' Time and the Production of Learning

Surprisingly, books on educational management give little attention to the allocation of resources at the micro level. Such treatises appear to be based on the assumption that educational organizations are designed to ensure that decisions made at higher levels are implemented in schools and classrooms; the teachers' role appears to be to implement policies determined by school boards and superintendents, while students are seen as recipients of services provided by educational systems. An expanded view of educational management, which regards teachers, parents, and students as decision-makers who help determine both the ends and means of education would permit reconsideration of these assumptions.

This new approach to administrative theory in education depends, in large part, on a recognition that the time of students and parents constitutes an important and costly educational input. Researchers studying educational productivity have thus far largely ignored students' time in the listing of inputs and outputs, apparently assuming that this variable is different from purchased inputs, such as teachers, textbooks, equipment and school buildings. Even economists, who often criticize educators for ignoring the value of students' time, have regarded the time of elementary school students, who are

prohibited by law from entering the job market, as having little value. However, the fact that students' time is not purchased does not mean that it can be treated as a costless commodity; since the time of students of all ages has alternative uses, time is costly because opportunities are foregone when it is used in one set of activities rather than another.[6]

The opportunity costs of students' time may be viewed in at least three ways. In the first place, there is the traditional economic view that students' time has value because earnings are foregone when individuals are in school instead of in the labor force. However, child labor laws and the mechanization of household chores have lowered the market price of children's time to near zero. (A partial exception to this statement, in our society, is the case of farm families at planting or harvesting time—here again, however, mechanization has, in much of the country, greatly reduced the pecuniary opportunity costs of rural children.) A second and probably more important aspect of opportunity costs deals with the learning which students forego when they are engaged in one educational activity or in pursuing one curriculum rather than another. The magnitude of these kinds of costs varies with the value of the foregone activity; if we distinguish between the mastery of those skills which are essential to further learning and the application of those skills in producing new learning, we may conjecture that foregoing the former activities may often result in higher opportunity costs than foregoing the latter, since foregoing skill mastery lowers the individual's ability to produce additional "human capital." This argument suggests that time may be worth more in the early grades than at subsequent educational levels. A third aspect of the opportunity costs associated with the use of students' time consists of the short-term consumption activities such as play or socialization which students forego when they are engaged in learning.

This notion that time is costly because it has alternate uses is basic to the development of a theory of resource allocation at the micro level. The implication of the theory for educational practice is that students' time, if costly, should be wisely used. However, the notion that educators should treat students' time as a scarce resource is not new, since educators have for many years been concerned with this issue. Its origins go back at least as far as the scientific management movement, which had a profound effect on the study and practice of school management at the beginning of the Century.[7] In its extreme form, the movement included an application to education of mechanical approaches to the improvement of productivity, including the use of time-motion studies to analyze teacher efficiency; although such procedures were probably as repugnant to educators then as they would be now, the broader notion that students' time is valuable and should be used as a scarce resource was widely accepted. Thompson (1915) reported on a large number of experiments having to do with economizing time in elementary schools, concluded that "Not many have indicated very much interest in the shortening of the period of education, but almost everyone, explicitly or by implication, would have much more accomplished within this period."[8] "The teacher is thought of as immoral if he wastes time or permits it to be wasted."[9]

During the 1930's and 1940's, the human relations movement in industry and the progressive education movement provided a welcome relief from the excessive emphasis on efficiency which characterized the early part of the Century, but in recent years a preoccupation with productivity in education has, for good or for ill, re-emerged. Like the earlier "Cult of Efficiency," the new movement places a heavy emphasis on fiscal analysis, cost control and a mechanical approach to management[10]; it is largely untouched by the recent theoretical work in students' time utilization flowing from the contributions of Becker and his colleagues in economics, and Bloom, Carroll and Block in education.[11]

This omission may result in part from a tendency to compartmentalize studies in educational administration from issues in curriculum, instruction, and home-school relationships; if so, the resulting myopia is unfortunate because inefficiency in education may result more from a waste of students' time than from a misuse of purchased resources. There is a vast difference between administrative decisions regarding students' time and the reality of the classroom, since much school time is spent on organizational chores and social interaction. More importantly, traditional teaching methods consisting of oral communication from a teacher to a group of students probably engage many students for only a small part of the school day. Bloom commented:

> There is little doubt that schools as well as individuals squander much of the time that is made available to them for learning and teaching. Schools, teachers, and students use time relatively poorly and the individual as well as the society pay dearly for the ways in which time is mismanaged during the school hours.[12]

A recent ethnological study of schools provided strong support for this observation. Cusick found that there was

> over three hours of the total time spent in school in which any single student can be expected to either spend his own time on procedural and maintenance details or wait while others tie up the class with their own.[13]
>
> . . . for any single Gates senior, the time spent actively engaged with some teacher over a matter of cognitive importance may not exceed twenty minutes a period for five periods a day. This is a high estimate. I would say that if an average student spent an hour to one and a half hours a day involved in subject matter, that was a good day.[14]

Our purpose is to provide a comprehensive basis for incorporating time allocation into the framework of educational management. We draw from recent work in economics and education to develop some aspects of a theory which will later be subjected to empirical test. We start with the proposition that while students' time is analogous to purchased inputs, it is also a unique resource whose quantitative and qualitative dimensions need to be analyzed.

Quantitative Variations in Students' Time

Investments in education consist of two types of resources, first purchased goods and services including teachers' time, books, materials, equipment and school buildings, and, second, resources which are not purchased but which are valuable because they have alternative uses. The most important input in the latter category is students' time which, like

purchased resources, has both a quantitative and a qualitative dimension. This Section deals with students' time from a quantitative perspective.

There are two quite different ways of viewing the quantity of students' time which is devoted to education. The first viewpoint considers the amount of time provided to students, and deals with decisions concerning the length of the school year, the length of the school day, the period of compulsary schooling, and the age range within which free (or subsidized) instruction is made available. The second perspective focuses on variations in the amount of time provided by students to the instructional process. These two aspects of decision-making, comprising on the one hand choices made by state and local agencies and on the other those made by teachers and students, interact with each other. For example, a lengthening of the period of free and compulsary education was made possible by an increased willingness of families to send their children to school, and of children to attend school. On the other hand, the availability of free schooling through high school and of subsidized college education has influenced the educational decisions of many parents and students.

Educational statistics do not provide a comprehensive reporting of schooling time provided to students. This is a significant omission, since schooling time may have an important effect on achievement.[15] In addition, schooling time as represented by the length of the school day, the length of the school year, and the distribution of schooling over the calendar year, (as represented, for example, in year-round schools), affect the quantity of purchased resources which are required. Finally, schooling time is important because a major portion of the investment made by society in high schools and colleges consists of the foregone earnings of students.

1. The length of the school year. It is common knowledge that the average number of years of schooling possessed by American adults has been increasing over time. Less well known is the fact that the length of the school year has also been increasing. Schultz pointed out that "The average attendance of enrolled pupils, age 5 to 15, was only 99 days in 1900, whereas it had leveled off at 159 days in 1957."[16] In early years of this century, when education in most of the country was locally supported, the length of the school year depended heavily upon local resources, and therefore varied among communities. Cubberley pointed out that in Nebraska, according to the Report of the State Superintendent of Public Instruction for 1901-2, "three hundred districts maintained less than a three months' term, and eight hundred and five more than three but less than six."[17] Welch (1973) presented data showing that, in 1920 the length of the school year was much greater for white students than for blacks. This differential has, by now, virtually disappeared. (See Table 4-1).

2. Length of the school day. David Wiley and Annegret Harnischfeger defined the amount of schooling provided to students as the product of the number of days in the school year and the number of hours in the school day. "If schooling is quantified in this simple way, we find large variations in the total number of hours of schooling per year (ranging, e.g., in the Detroit EEOS data from 710 to 1150 hours). . . Typical pupils in some schools receive fifty percent more schooling than pupils in other schools."[18] While it is difficult to generalize from this finding to other school systems since data concerning the amount

of schooling provided to students are seldom reported, the above observations receive some collaboration from an AFT study which reported that the length of the school day for elementary school pupils in school districts in several st.ces ranged from four to six hours.[19]

Table 4-1

Comparison of Trends in Enrollment, Attendance, and Expenditures for Segregated Negro Public Elementary and Secondary Schools in the Southern United States to Trends for All Schools, 1919-54

Characteristic:	1919-20	1929-30	1939-40	1949-50	1953-54
1. School Term and Attendance					
1. Average number of days schools were in session					
(a) Negro Schools	119	132	156	173	177
(b) All Schools	162	173	175	178	179
2. Percent of pupils enrolled in average daily attendance					
(a) Negro Schools	67.3	72.1	80.4	85.3	85.1
(b) All Schools	74.8	82.8	86.7	88.7	88.9
3. Average days attended per pupil enrolled					
(a) Negro Schools	80	97	126	148	151
(b) All Schools	121	143	152	158	159

(Source: Welch, 1973, p. 900)

3. Time supplied by students. The second approach to time analysis consists of studying the amount of time supplied by students; this may be either greater or less than the schooling time provided. It is greater if students supplement the school day with out-of-school study, less if students absent themselves from school, or if, when in attendance, they are not involved in learning activities.

In general, it may be assumed that the amount of time supplied by students to the schooling process depends on the relative attractiveness of schooling, and alternative uses of their time. If students are in poor health, the "cost" of school attendance will be increased, since attending school may result in physical sacrifices.[20] If students have attractive work or recreational opportunities, their attendance at school may decline. Similarly, if the attractiveness of the school or of the teacher is low, alternative uses of time--however drab these may be--may appear superior to attendance at school.

a. Student attendance. Within the constraints imposed by compulsary attendance laws, the amount of time provided for schooling by students and their parents may vary considerably. Much of the research in this area has centered on the school-leaving age; however, variations in attendance before the decision is made to terminate enrollment are also considerable. It has been reported, for example, that "On any current school day, many urban schools report more students absent than present in school."[21]

While there is a shortage of analytic data concerning school attendance, it is known that attendance rates have been increasing. In 1929-30, average daily attendance in the country as a whole was 82.8 percent of the enrollment; in 1971-72, attendance rate had climbed to 91.7 percent. There is considerable variation among states in attendance rates. (See Table 4-2) Attendance rates probably varied even more within states, within large school districts, and among categories of students.

Table 4-2

Enrollment and Attendance in Six States

State	Average Length of Term in Days	ADA as Percent of Enrollment	Average No. of Days Attended per Pupil Enrolled
Illinois	178.9	88.5	158.4
Missouri	176.0	84.5	148.8
Arizona	181.4	85.1	154.4
Connecticut	180.0	91.8	165.3
Michigan	180.0	92.0	165.6
Nebraska	179.1	92.7	166.0

Source: U. S. Department of Health, Education and Welfare. National Center for Education Statistics. Statistics of State School System 1971-72, Table 22, p. 45.

Since students' time is the most ubiquitous input utilized in the production of education, one is inclined to postulate the existence of a positive relationship between school attendance and attainment. However, we have no theoretical or empirical reason for assuming that the relationship is a simple one. In a British study, Douglas and Ross found that the achievement of upper middle-class 11-year-old children was not substantially affected by a history of prior absence.[22] Among lower middle- and working-class children, on the other hand, absence from school in prior years appeared to have a considerable negative effect on achievement, especially among those whose school work was consistently interrupted. The affect on achievement of absences in the earlier years was quite small, while absences in the last two years of primary school had a greater negative influence on test scores.[23]

However, while absences may have an effect on school achievement, it would be a mistake to regard school absence as an exogonous variable.* Absence and achievement may interact with each other since while time in school may affect attainment, students' and parents' decisions concerning attendance may be influenced by the success or failure of students in their academic pursuits. In particular, a failure to master those skills which are essential to the development of additional human capital may lead to the conclusion that the value added by an additional day in school is worth less than other uses of the same time. On the other hand, some parents may conclude that low achievement necessitates regular attendance. At any rate, both attendance and achievement are related to social class. Douglas and Ross found that attendance and

*That is, a variable which is external to the explanatory model.

SES interact in their effect on achievement.[24] They found also that social class has little or no influence on school attendance in the early years of schooling, while in the later years of primary school a gradient emerges with an excess of absence among children from working-class homes.[25]

b. Homework. Homework may be viewed as an extension of the school day; homework is also an extension of the home's production of human capital which begins in the early years. The costs of homework include the "value" of opportunities which students forego through studying at home, the time of parents and siblings, space, and other inputs. The benefits include avoiding whatever sanctions the school imposes for noncompletion of assigned tasks, and obtaining the benefits which result from additional learning.

We assume that there is an interactive relationship between the amount of time a student allocates to homework and his present stock of human capital. Students who have developed a high level of learning efficiency are more likely to devote long hours to homework, since their rewards, in terms of additional learning as well as in recognition by teachers and parents, are likely to be high. On the other hand, if all else is equal we would expect those who allocate additional time to education to perform better in school-related subjects.

c. Student Involvement. The length of the school day and the school year, even when adjusted for attendance rates and homework, does not provide an accurate measure of the time students supply for their own education. Several scholars have pointed to the discrepancy between schooling time provided for students and the time during which they are actively engaged in learning.[26]

Bloom concluded from his studies of student involvement that "some students were spending three times as much time in active learning as others during the same period of elapsed time."[27] In another article, Bloom stated that "students appear to approach different learning tasks with different amounts of perseverence owing . . . to the frequency of reward and evidence of success they have experienced in the same, similar, or related tasks."[28]

The above analysis suggests a theory of student decision-making according to which individuals supply their own time to schooling in accordance with the costs and benefits they perceive. If the costs of attendance increase, (usually through an increase in the opportunity costs of students' time), students will be likely to reduce their attendance by being absent, cutting class, being inattentive, or leaving school completely. If the short-term benefits (for the most part, success in learning) or the long-term benefits (better choice of jobs or improved income) improve, students may allocate additional time to schooling.

Both aspects of our analysis (time provided by the school and time provided by individual students) have implications for efficiency and equity. We discuss the policy implications briefly at this point.

Policy Implications. Some observers have concluded that since students' time is valuable, the amount of time provided for formal

schooling should be reduced. Decreasing the length of a school day or school year, or diminishing the length of compulsary schooling or the duration of the various phases of schooling (such as grade school, high school, college, or professional education) would provide two kinds of economies. In the first place, it would permit the student to benefit from alternative uses of time, including gainful employment. In the second place, reducing the time students spend in school would result in economies in those inputs which are purchased with money, especially teachers' time and space.

A 1913 Bulletin of the United States Bureau of Education recommended a decrease in the period of schooling[29]; recent proposals have suggested a reduction in the time devoted to secondary and higher education. Machlup recommended lowering the school-leaving age to 15, stating: "The way to get better-educated people in the United States is to make them learn faster, study more intensively, so that a greater percentage of those whose minds will have been stretched through intensive work in earlier years can benefit from a likewise somewhat improved college education."[30] A prestigious commission has recently recommended that, on an experimental basis, youths of age 16 and over be given the alternative of "finishing high school through his regular school or shifting to employment-with-school. . ."[31]

A possible alternative to a decrease in the amount of schooling which is provided to students is to change the manner in which time is scheduled, either during a given year, or over an individual's lifetime. Year-round schooling is a procedure designed to economize in the use of certain inputs--for the most part, buildings and major equipment--through staggering the vacation period, so that a portion of the student body will be on vacation at any given time. Since many school systems are now experiencing falling enrollments, school buildings are often a surplus commodity, and the year-round school has lost some of its attraction.

Another approach is to make schooling time available over a relatively long-time span. One possibility would be to permit students to leave school at an earlier age than is now possible in most states, while requiring that they continue their education on a part-time basis. Another possibility is that opportunities and incentives for continuing education may be made available for the entire population, so that schooling time and working time may be combined by individuals at all ages in a manner which corresponds to individual preferences and needs.[32]

The conclusion that students' time is costly might lead to quite different policy conclusions. One point of view is that if students' time is costly, it should be economized by shortening the total period during which students are exposed to schooling. However, the type of analysis which leads to this conclusion may be faulty; if additional hours of schooling lead to increased learning, the benefits of additional schooling may exceed the costs. This apparent paradox suggests that an analysis of time use should include examining alternative uses of time <u>in school</u>, as well as external alternatives.

One obvious way to improve the productivity of an educational system is to attempt to influence the variables which determine the amount of their own time which students provide to their schooling. The additional time which students are induced to supply during the school

day or school year is, from the point of view of the school system, costless; this apparently costless resource is apparently an important determinant of learning outcomes.[33]

If we examine the problem from a micro perspective, it will be clear that students will devote more time to their education so long as the additional benefits they perceive will exceed their additional costs. Parents and educators often bring to students' attention the long-term advantages, in terms of jobs and income, of remaining in school. However, students are probably also influenced by the short-term benefits of the learning (rather than the earning) that is produced as a result of their investment of time. This is, at any rate, one inference which might be drawn from Bloom's conclusion that the percent of time students spend on task is largely determined by "the student's achievement over the preceding unit of the course," as well as by "his interest in the subject, and by the quality of instruction provided.[34]

To summarize this section, it is assumed that students act as partially independent decision-makers, who supply their time to the production of their own education. It is axiomatic that the amount of time they will supply will be affected by their perceptions of the benefits and costs which will result. Educators can intervene in the student time supply function by influencing these benefits and costs. Since learning is affected by the quality as well as the quantity of students' time which is supplied to education, educators are also concerned with methods of improving student efficiency.

The Quality of Students' Time

The quantity of time which students allocate to learning is, we have seen, an important determinant of educational outcomes. No less important is the qualitative aspect of students' time. While two students may spend the same amount of time on a given cognitive task, the first may produce more learning during that period than the second; the quality of time of the first student is said to be superior to that of the second.

Time quality is an important but seldom recognized variable for those who are interested in the formulation of educational policy. If, among a group of students who are receiving equal investments of purchased resources there are some who learn more rapidly than others because their time quality is relatively high, substantial inequalities in outcomes may result. Compensatory programs which involve spending money on less efficient students than on those who are more efficient may necessitate either substituting purchased resources for students' time, a procedure which, as we shall show, may not be effective, or using resources to improve the value of time for students who are relatively inefficient in the production of learning. The second procedure may improve both efficiency and equality.

Defining the Quality of Students' Time. We define the quality of a student's time as the ratio of learning produced (in a given subject) to time expended; time quality is therefore synonymous with student efficiency, and is specific to the student and the subject area.* Since intelligence tests have been commonly used to predict achievement and "may be regarded as measures of scholastic aptitude or ability to succeed in our schools,"[35] they constitute one measure of student efficiency; however, intelligence test scores are, for the most part, not specific to curriculum areas; there is much controversy over the nature of intelligence; and many so-called intelligence tests are actually measures of achievement.[36] A more useful measure of time quality is a score on a criterion referenced test of entry level performance, given at the outset of a specific unit of instruction, and providing a measure of the student's possession of the necessary prerequisites for success in that unit.[37]

Concepts developed by John Carroll provide important insights into the relationship between time and student ability. He pointed out that:

> It is also well known . . . that pupils vary a great deal in the rate at which they learn—some learn very fast, others much slower, but, despite these differences in rate of learning, nearly all pupils can learn what they are supposed to learn in school, given enough time.[38]
>
> The amount of time that a student needs to learn a given task under optimal learning conditions is, in the author's opinion, a reflection of some basic characteristic or characteristics of the student that may be called aptitude.[39]

Carroll's definition of aptitude corresponds to our term "learning efficiency," which refers to the amount of time students take to master a given amount of new learning, or the amount of learning a student can produce in a given period of time. Christofferson (1971) pursued this approach and developed a method for estimating the "shadow price" of students' time.**

> Since time to completion of a learning task usually varies in such a way that the top five percent of the students learn about five times as fast as the low five per cent, the shadow prices of their time, assuming stable learning rates, should also have the proportions of five to one, the fast student's time being five times as valuable as the slow student's.[40]

Student efficiency is, according to Christofferson, proportional to the learning rate at the margin and inversely proportional to time to completion of the marginal task.[41]

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*Student efficiency might be more accurately defined as the ratio of learning produced to the total value of purchased and unpurchased inputs which are used. To simplify our argument we will use the definition which is stated above.

**The research of Bloom and his colleagues suggests that student efficiency may be improved by appropriate investments of time and other resources and by the use of specific classroom technologies, in particular mastery learning. The shadow price of students' time is the price which would have to be assigned to it, in order that the effect on student achievement of the last dollar spent on students' time might be equal to the effect on achievement of the last dollar spent on a purchased input such as teachers' time.

Student efficiency (or time quality) is assumed to result from previous investments of time and purchased resources as well as from genetic factors. Efficiency varies among students and for a given student it varies among subject areas. Efficiency is developed over time; hence a longitudinal model of investment is implied.

The following set of equations, which encapsulate our view of the production of educational efficiency, is a modified version of a model developed by Leibowitz.[42]

$$E_{i,j,1} = f_1(G_{i,j}, I_{h,i,j,o}, R) \quad (1)$$

$$E_{i,j,2} = f_2(G_{i,j}, I_{h,i,j,1}, I_{s,i,j,1}, R, E_{i,j,1}) \quad (2)$$

. . .

$$E_{i,j,t} = f_t(G_{i,j}, I_{h,i,j,t-1}, I_{s,i,j,t-1}, R, E_{i,j,t-1}) \quad (3)$$

$E_{i,j,n}$ indicates the learning ability of student i in subject j at the beginning of year n; $G_{i,j}$ is the genetic ability of student i, specific to subject j; $I_{h,i,j,n}$ is the home investment on student i in subject j and year n (o represents the preschool years); $I_{s,i,j,n}$ is the schooling investment on student i in subject j and year n; R_a represents a set of terms representing interactions among genetic ability, home investment and school investment.

The model is based on the proposition that a student's efficiency at the beginning of a given school year is a function of his efficiency at the beginning of the previous year, home and school investments during the previous year, genetic endowments, and an appropriate set of interaction terms. At the beginning of the first year of school, a child's efficiency (or embodied "human capital") is assumed to depend on his genetic endowment, investments made on his behalf in the home from time of birth to enrollment in school, and the interactions among these variables. The model therefore links home and school variables in a general longitudinal model of resource allocation, and prepares the way for a more detailed discussion of the production of student efficiency. We turn first to the allocation of resources for the development in the home of students' time quality.

Home Production of Student Efficiency

Stimulated by the theoretical contributions of Gary Becker, economists have recently turned their attention to such apparently non-economic phenomena as marriage, fertility, and child rearing.[43] Rather than regarding the home as merely an agency devoted to the consumption of goods, Becker depicted it also as a producing agency which combines the time of husband and wife with a variety of goods to produce "commodities" such as meals, entertainment and child care.[44] Among the decisions made by married couples are the number of children they will have and the resources they will invest in the development of their

children's aptitudes. As Leibowitz (1974) pointed out, child rearing is analogous to schooling:

> By the time children enter first grade, significant differences in verbal and mathematical competence exist among them. These differences reflect variations in (1) inherent ability, and (2) the amount of human capital acquired before the age of six. The stocks of acquired human capital reflect, in turn, varying inputs of time and other resources by parents, teachers, siblings, and the child. The process of acquiring preschool human capital is analogous to the acquisition of human capital through schooling or on-the-job training.[45]

Subsequent research focussed on the allocation of time by parents to the care and education of their young children. Hill and Stafford used survey data to study the effect of the presence of children in the home on the allocation of the time of mothers and fathers within high, middle, and low social class groups.[46] They found that having children in the home had no effect on the time allocation of fathers. In the case of mothers, the effect varied among social classes; "the amount of housework time allocated to preschool child care by wives from the lowest SES group is significantly less than that allocated by the middle and high status wives. . . "[47] High status wives forego a higher potential wage when they stay home with their children than do wives from middle or low status homes. Considering both the difference in time allocated and, in particular, the difference in opportunity costs, Hill and Stafford estimated that "the value of nonmarket inputs invested in a child's "capital embodiment" differs by a ratio of almost 5:1 between the high and the low SES groups."[48]

Leibowitz used several measures of home investment obtained from the Terman study of gifted children, in order to determine the effect of preschool investments on children's ability. Previous research showed that the educational level of fathers and mothers was positively related to both the amount of time parents spent with their children and the latter's IQ; Leibowitz' earlier work, which showed that mothers' time expenditures on children exceeded the fathers' by at least a factor of 4, suggested that mothers' education would be a better predictor of IQ than the education of fathers.[49] Leibowitz obtained a direct measure of the time parents spent with children from the Terman data, which indicated whether parents carried out a substantial amount of instruction along specific lines, and whether parents spent considerable time reading books and telling stories to children. She found that even within this sample of very able children which, due to the constricted range of ability, might not have been expected to yield significant results, home investment variables were positively related to IQ for boys and older girls; also, mothers' education but not fathers' was related to IQ, suggesting that home investments rather than genetic factors are the basis for the observed relationship between parents' educational level and children's ability.[50]

There is, in short, considerable evidence that home investments in children's ability vary substantially, and that these investments affect the amount of human capital possessed by children when they enter

school.* Furthermore, children who have received a greater than average preschool investment in their talents will, for a number of reasons, be more likely than less fortunate children to receive superior investments of purchased resources in school.

A major focus of educational policy has therefore been on the preschool investment in children's learning capabilities. One aspect of this emphasis is the early education movement, which has extended schooling downward to the earlier ages of a child's life. In recognition of the important role which parents play in the production of learning ability, there have also been attempts to train parents to be more effective in teaching their children. A promising development combining the early education and parent education approaches has been the Child-Parent Centers which have operated successfully in a number of locations; in these Centers, parents are required to spend at least one half day a week or two full days a month in the school assisting the teachers. Stafford and Hill suggested that a more macro approach to the problem might be desirable; their proposal was that the nation should make use of income maintenance programs to make it possible for low income mothers to spend more time at home than many presently do, and hence to increase their investment of time in their children's education.[51] However, merely making more time available without also improving parental effectiveness may not have the desired results.

Turning to the production of student efficiency in schools, we assume that decisions made in the classroom are affected by parents' prior decisions to allocate resources to their children's learning. The demands which parents make on schools are not unrelated to their earlier behavior, since those parents who have invested heavily in their children's capabilities are likely to attempt (by their choice of a place of residence or by formal and informal mechanisms for putting pressures on school authorities) to obtain superior school resources for their children. Parents' decisions may affect those of teachers who, attaching value to the time of their students, allocate resources differentially among them. It is also postulated that students will be affected by their view of the value of their own time when they allocate it to the educational process.

Producing Learning Efficiency in Schools

A substantial portion of most educational investments is designed to improve students' ability to produce additional learning.[52] The development of information processing skills (or, in the vernacular, "learning to learn") takes place at all educational levels; for example, premedical education produces the ability to benefit from medical school; advanced courses in mathematics provide a background for the study of economics; most importantly, the development in the early grades of the ability to read and compute provides the necessary foundation for additional learning.

The development of learning efficiency requires the use of resources in both the home and the school. The previous Section of this Report summarized studies which suggest that the human capital accumulated by children prior to enrollment in school varies among children, in a manner which is explained at least in part by the use of parents' time and purchased resources. In the next Section of the Report, we

*It would, of course, be a mistake to assume a one-to-one relationship between the quantity and quality of home investments and students' ability on entering first grade. Genetic factors cannot be ignored; these in turn interact with the various resources which are made available to preschool children.

will examine the relationship between the manner in which resources, including students' time, teachers' time, space, books and equipment are combined in classrooms, and the implications of these combinations for the production of desired outcomes.

The origins of the analysis lie in a number of theoretical and empirical studies of the production of education. The purpose of these production function studies is to identify categories of inputs which can best explain differences among schools in educational outcomes. Most such studies utilize data which are aggregated to the level of the school or school district. Our approach will use disaggregated data as a basis for examining differences in resource allocation among and within classrooms.

The key variable used in our analysis is the value which is assigned to students' time. Time quality or student efficiency is important for two reasons. First, student efficiency is obviously an important educational "output"; second, it will be postulated that the value which is assigned to students' time by teachers, administrators, parents and students is an important determinant in the manner in which resources are combined within classrooms. Student efficiency is an important determinant of the productivity of educational systems, since the success of such systems in using purchased resources for the attainment of educational objectives will depend heavily on the efficiency of learners. Managers of educational systems may improve productivity by either selecting efficient students or investing in the efficiency of presently enrolled students. The first procedure is the easier, as long as educational institutions are able to be selective in their entrance requirements; the "better" colleges and universities tend to be those who admit only students who are academically talented, and the so-called "good school systems" are those which, because of the nature of their clientele, enroll students who already embody a high level of human capital.

In the short run, students' abilities in a given educational institution are fixed, and the efforts of its members are devoted toward improving student efficiency as well as utilizing the present talents of students in the learning process. These efforts entail decision-making by teachers, parents and students; the next section deals with that portion of the total decision-making systems of educational organizations which operates within the classroom.

Resource Allocation in the Classroom

The view of resource allocation which pervades the literature constitutes what we might call the "fixed input model." This model implies the existence of a single "best" combination of inputs, with some variations across curricula areas (such as vocational education and home economics) and across categories of students, (such as special education). With these exceptions, a given number of students is said to "need" a specific number of teachers with certain defined qualifications, specific amounts of space, quantities of books, and numbers of specialists such as guidance counselors, reading consultants, and administrators. The model is sanctified in administration textbooks,

union contracts, and, most importantly, common practice. Variations from the norms are defined as differences in the quality of schooling; thus, if the "normal" class size is 25 students per teacher, a school district with classes of only 20 is regarded as superior and one with classes of 30 or more students as inferior. Since such variations are due, for the most part, to differences in the tax base of local districts, there is a commonly accepted belief that educational quality depends directly on the tax base and the level of educational expenditure.

The fixed input model provides a useful basis for allocating resources at the state or school district level, since it provides a set of rules which can be applied equally to all units, thus avoiding overt discrimination among schools or school districts. However, an equal distribution of money among educational agencies should not be equated with equal educational opportunity, since, even in the most rigid classrooms, resources are allocated unequally among students; furthermore, inequalities in the value of students' time result in differences in the ability of students to make use of the purchased resources which are provided to them.

The manner in which resources are combined within classrooms depends upon decisions made by teachers and students. Teachers influence performance standards for students, and allocate their own time, that of students, and materials so as to facilitate the achievement of pre-determined goals. Both the performance standards which are set and the resources which are provided will differ among students to a greater or lesser degree.* Students help determine their desired level of performance, and combine their time with that of teachers and other resources in a manner which is affected, but not completely determined, by teachers' decisions. In some cases, teachers and students will disagree as to ends and means, and a compromise will be reached. Classrooms therefore constitute complex decision-making systems in which a variety of actors attempt to maximize results and minimize costs. We turn now to a formal examination of these systems, looking first at general possibilities for resource substitution in classrooms, and second at factors which affect decisions made by teachers and students.

1. Substitution possibilities in education. The analysis is based on the assumption that, within certain limits, it is possible to use more or less of one input in combination with less or more of another, and obtain similar results. For example, a library assignment may sometimes be an acceptable substitute for lectures, while excellent teaching or tutoring may on occasion make up for an inadequate supply of books and other instructional materials.

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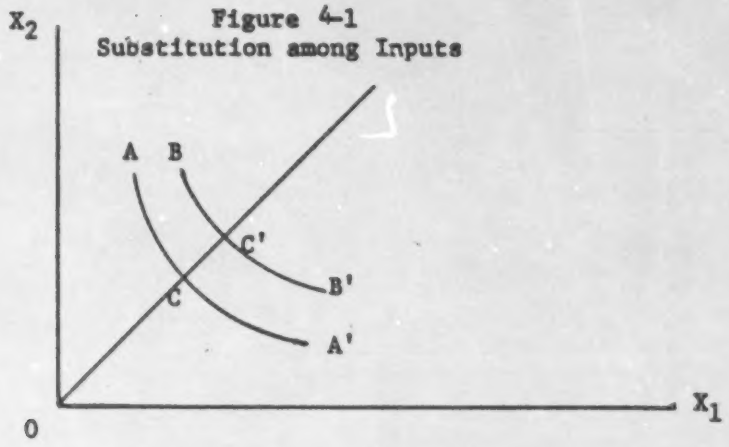
*Even in the case of mastery learning, where all students are required to reach a given level of mastery, the faster students may have surplus time which must be spent on the attainment of other objectives.

Figure 4-1 is a mapping of the possibilities of substitution between two inputs, say teachers' time and other purchased inputs (including books, other printed materials, maps and globes, and chalkboards). The two axes $0X_1$ and $0X_2$ represent the two types of input; the line AA' joins points which represent different input combinations but the same level of outcome.

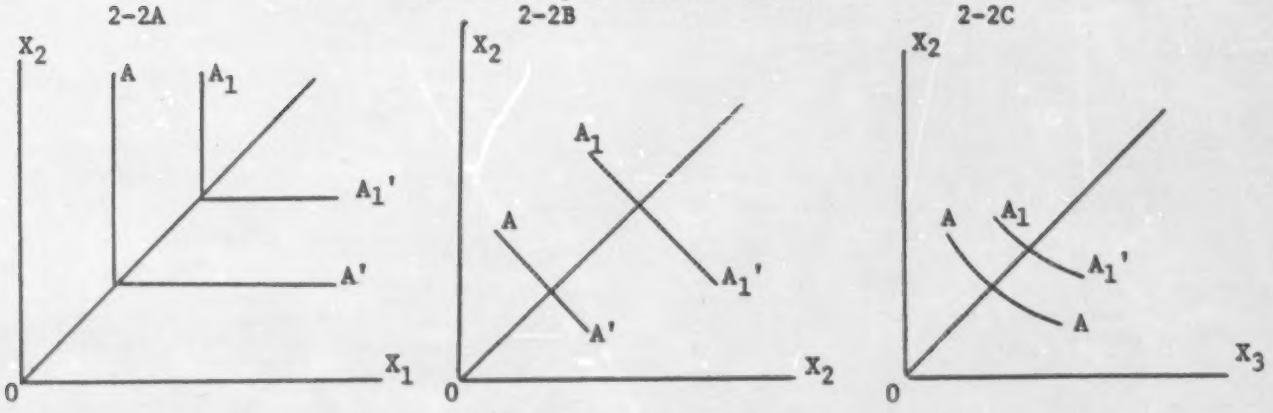
Figure 4-1
Substitution among Inputs



BB' joins points on a higher level of output.

In the literature of micro-economics the curves are technically known as iso-product lines. The curvature of the iso-product line is measured by the "elasticity of substitution," which reflects the ease with which one input may be substituted for another. If the line forms a right angle, the elasticity of substitution is zero, implying that no substitution is possible between two inputs. If it is a straight line, the elasticity of substitution is infinity, suggesting that the two inputs are perfect substitutes, as is the case with two sets of basic readers which are approximately equivalent in instructional value. (See Figure 4-2.)

Figure 4-2
Ease of Input Substitution



Elasticity of Substitution = 0

Elasticity of Substitution = infinity

Elasticity of Substitution between 0 and infinity

Bloom reported findings which suggest that students with more effective learning and studying procedures are less affected by variation in the quality of instruction than are students with less effective learning skills.[53] This suggests the possibility that more efficient students are characterized by a higher elasticity of substitution than less efficient students. Our empirical work may throw light on this hypothesis; the observation that teachers sometimes assign library research to the more competent students while they provide intensive personal instruction to the less efficient supports this point of view.[54]

We now include students' time in our analysis. Previous sections of this Chapter support the position that students' time is an input which is analogous to purchased inputs. If this is the case, substitutions may, under certain circumstances, be made between students' time and purchased inputs. For example, some students may compensate for inadequate instruction by spending additional time in the library; on the other hand, crash courses in foreign language may consist of substantial amounts of purchased resources combined with a relatively small amount of students' time.

Figure 4-1 may be re-interpreted so that OX_1 represents the dollar value of purchased resources, while OX_2 stands for the number of hours of students' time with which purchased resources are combined; AA' and BB' again represent two output levels, the second being higher than the first. However, this depiction is incomplete because outcome levels depend on student efficiency (or time quality) as well as the amount of students' time and other resources which are used.

Figure 4-3
Student Efficiency and Input Substitution

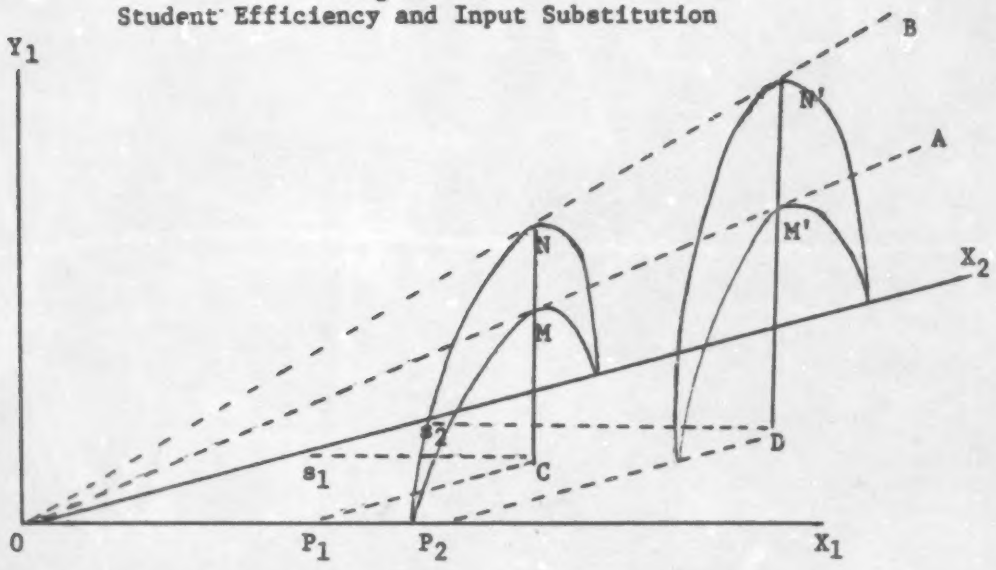


Figure 4-3 explicitly indicates the third dimension of the analysis; axis OX_1 represents the dollar value of purchased resources which are used; OX_2 is the amount of students' time; OY_1 is the output level.

OA and OB join the points of maximum outcome on the production surfaces attained by two students, A and B. B is the more efficient,

since at each combination of inputs, he has a larger output level. (For example, if p_1 units of purchased resources are combined with s_1 units of students' time at point C, A's output is CM, while B's is CN.) DM' is approximately equal to CN, indicating that the change in input level from Op_1 and Os_1 to Op_2 and Os_2 has resulted in increasing A's performance to B's former level. This is, of course, a desired result of compensatory education, which usually implies increasing the quantity or quality of resources supplied to those students who have not yet reached the desired level of efficiency. However, if student B is provided the additional resources that are supplied to A, his advantage over A (M'N') is even greater than it was before (MN).*

2. Decision-making in the classroom. This section deals with the factors which are assumed to affect the decisions of teachers and students with respect to the flow of resources in classrooms. We define resource flows as those services which emanate from human beings, especially teachers, as well as from material goods such as books, and which are utilized by students. This emphasis helps distinguish our work from traditional production function studies which for the most part measure stocks, not flows of resources; for example, most such studies use as independent variables the number of teachers who are present in schools, together with their qualitative properties (age, experience and education), the number of books in the library, and the number of study carrels, computer terminals, and electric typewriters which are used for instructional purposes. Our emphasis is on the amount of a teacher's time which is made available to and used by each student, the books read by each student, and the utilization by students of units of equipment and classroom space.

The flows of resources which may be observed in classrooms result from choices made by semi-autonomous decision-makers, especially teachers and students. Decisions made by teachers are particularly important to the operation of the system. Teachers structure the broad configuration of resource use which characterizes a classroom,** and they also make specific decisions with respect to the quantity and quality of resources which flow to each student. We can expect their behavior to be patterned and systematic because their behavior is organized by their own personality and value orientations, their training, the environment within which the school is located, and the expectations placed on them by their peers as well as by administrators,

Differences in the structuring of resource flows are expected among classrooms within a school and among schools and school districts. While these differences may be due in part to the idiosyncracies of teachers, powerful environmental forces are expected to affect resource configurations (or technological mixes, to be discussed in Chapter 5). Furthermore, communities and teachers select each other, so that we anticipate finding more variation in classroom technology among than within school districts, especially where different schools serve clienteles characterized by diverse socio-economic backgrounds.

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*Figure 4-3 incorporates certain assumptions about returns to scale.

**See Chapter 5.

Teachers are, of course, constrained in the types of behavior which they may exhibit. The availability of resources constricts their behavior; for example, an entirely different set of decisions is possible if a teacher aide is assigned to a classroom than if the teacher is the only adult working with a given class. Decisions are also constrained by parental expectations; the level of overt participation by students in classroom decisions which may be accepted, welcomed and even required in an upper-class school might be discouraged and possibly frowned upon in a school serving working-class children. Administrative pressures may also affect teachers' decisions; a teacher might find it difficult to make the types of choices with which she is comfortable if the school principal favors, for example, uniformly structured classrooms, on the one hand, or differential structuring on the other.

a. Teachers' decisions. Of all the members of educational systems, teachers play the most important part in allocating resources among students, since the total structuring of resource within the classroom depends on the teacher's organization of the learning system as well as on specific decisions to provide resources to students by means of lectures, discussions, small group activities and the assignment of seat work. Studies previously cited indicate that resources flow unequally to students; our present purpose is to provide a systematic framework within which to examine these inequalities.

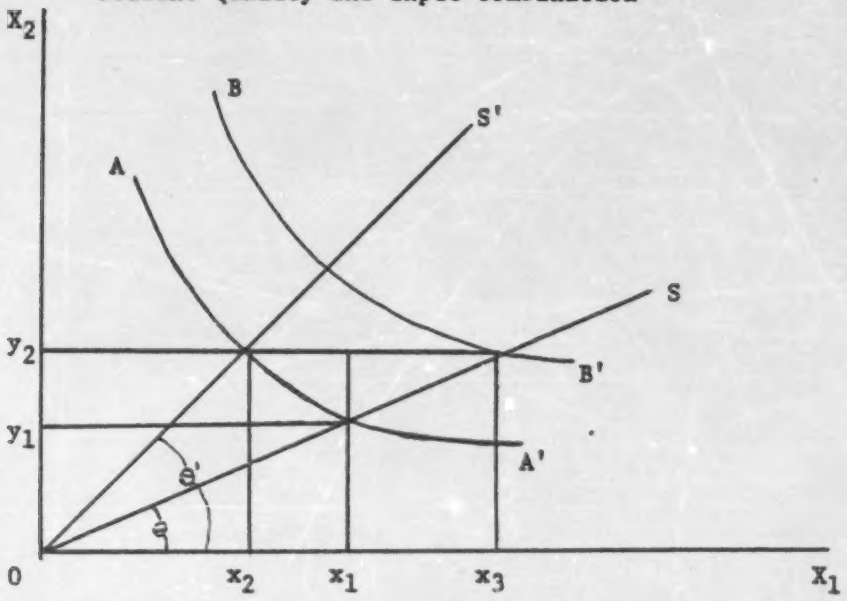
It is assumed that the single most important variable which influences within-classroom resource flows is the value which is assighned to students' time. Two reasons are given for this statement. First, the aggregate amount of human capital which results from previous investments in students' aptitudes is very high; in the case of middle- and upper-class students this value may far exceed the capital embodied in the teacher and in the physical resources of the classroom. Second, the value of students' time is of overwhelming importance because it constitutes the primary input into the production of additional learning.

Students with higher efficiency (or time value) can produce more learning in a given period of time; since their time is valuable, production theory suggests that in their cases, a given amount of students' time will be combined with a greater than average amount of purchased resources. To take a common example, if the teacher assigns a body of work to the entire class, some students will complete it in less time than others. If the time of the faster students is not to be wasted, they will need to be given additional work; hence, in addition to the time spent with the class as a whole, the teacher spends additional work preparing, assigning, and grading assignments for the more efficient students.

Figure 4-4 provides a diagrammatic presentation of the above analysis. The axes OX_1 and OX_2 represent quantities of purchased resources and students' time, respectively, while the curves AA' and BB' represent two levels of outcome each of which joins points

representing different combinations of the two inputs. Two rays drawn from the origin (OS and OS') which make angles θ and θ' with the horizontal axis intersect the curves in such a way as to represent combinations of students' time and purchased resources which would permit two students S and S' to attain the same level of outcome.

Figure 4-4
Student Quality and Input Combination



In attaining the outcome represented by the distance of curve AA' from the origin, student S receives $0x_1$ units of purchased resources which are combined with $0y_1$ units of his time; student S' is allocated $0x_2$ units of purchased resources to be combined with $0y_2$ units of time. In other words, since S is a more efficient producer of learning than S', the former student tends to receive more purchased resources in combination with a given amount of time than the latter. If we assume, as seems reasonable, that S uses as much of his time as S', he has the ability to use even more purchased resources $0x_3$, and may reach a higher level of performance, BB'. The analysis suggests that angle θ is inversely proportional to student efficiency; the larger the angle the lower the efficiency, and hence the lower will be the anticipated performance level.

The hypothesis that emerges from this analysis corresponds to the Biblical proverb "To them who hath shall be given." If we make comparisons among school districts or within classrooms, we will expect to find that those students who have already received large investments at home and in school for the development of their cognitive skills will be likely to be the recipients of larger educational expenditures, better quality teachers, and superior books and equipment than those students who have not benefited from substantial home and school investments. This apparent violation of the principle of equality in education is, to be sure, partly

justified in terms of one commonly used definition of equity or fairness, namely that each child should be permitted to benefit from education to the extent permitted by his level of measured ability.

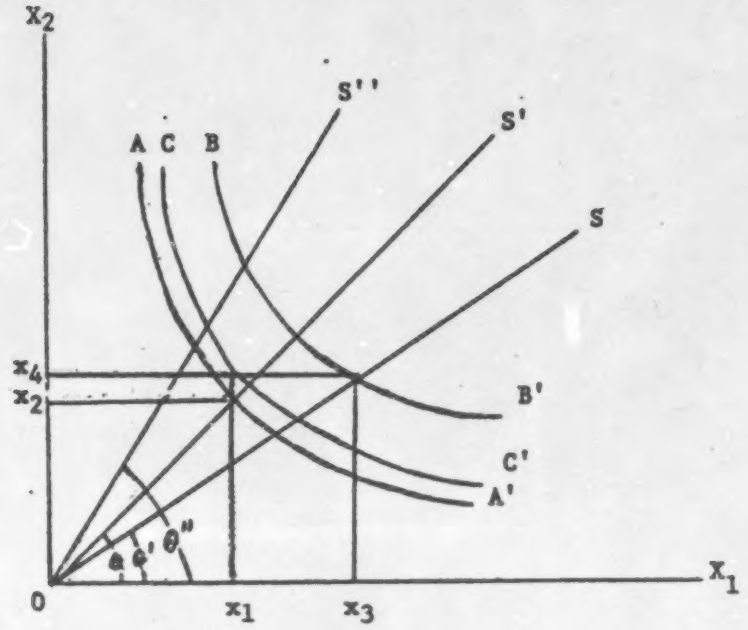
b. Students' decisions. Many of the problems inherent in attempts to analyze the production of education result from a failure to explicitly recognize the role of students and parents in setting goals and allocating time. As has been seen, students vary in the total amount of time they provide to education. Such phenomena as differences in the total amount of time students remain in school, truancy and absenteeism, class cutting, and inattention in class all contribute to substantial variations in the total commitment of time.

We have assumed that the amount of time an individual contributes to the development of cognitive ability depends in part on the human capital (in the form of previous learning) which he has accumulated, and particularly that part of human capital which we have termed learning efficiency. Two opposing tendencies are postulated; in the first place, the student with a relatively high level of learning efficiency will be willing to contribute his time (by remaining in school longer, attending regularly, and attending in class) because each unit of time contributed results in substantial increments in learning. On the other hand, the more efficient student recognizes that the time he contributes to learning a given subject is costly because his opportunity costs are relatively high; these costs result from the fact that by studying one subject he is foregoing substantial learning in another curricular area. Consider for example the student who, in high school, has accumulated substantial knowledge of astronomy. Because of the knowledge he has accumulated, time has become more valuable, and he will combine it with costly purchased resources, such as a telescope, books, and the time of a parent, teacher or other resource person. The time he devotes to astronomy and related areas such as mathematics is increasingly valuable, while the high opportunity costs associated with studying English literature or unrelated aspects of history and civics may cause a decreased investment in these subjects.

Two propositions are drawn from the above example. The first is that, as a student's time becomes increasingly valuable, he is likely to attempt to combine it with costly purchased resources. The second is that the value which a student assigns to his time may differ across subject areas, so that the cost of studying subject A is partially dependent on a student's efficiency in subject area A and partly on the opportunity costs which result from his efficiency in subject B.

Students' time and purchased resources. We hypothesize that the higher the value which a student (and his parents) assigns to his time, the greater will be the tendency to combine a given amount of students' time with a larger than average value of purchased resources. Parents who have invested heavily in a student's efficiency will attempt through their choice of a place of residence[55] and their influence on the school to provide the student with an expensive combination of human and physical inputs. Students who learn easily and quickly will, however inadvertently, place additional demands on the time of their teachers and on other purchased resources. (See Figure 4-5.)

Figure 4-5
Students' Time and Purchased Resources



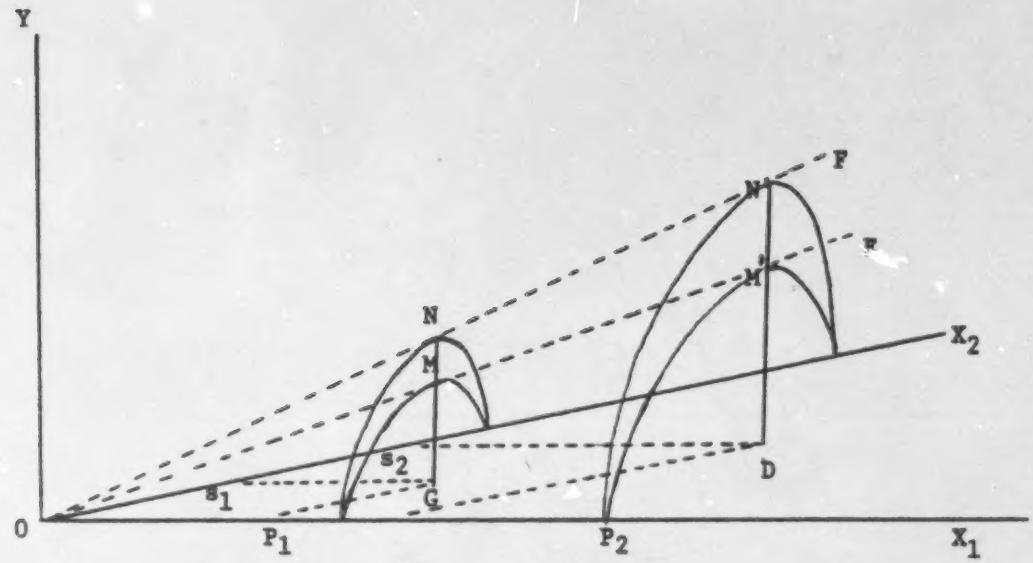
In Figure 2-5, OX_1 and OX_2 represent the dollar value of purchased resources and the quantity of students' time which are combined to produce learning in a given subject area. The average ability of the class is represented by the ray OS' which makes a 45 degree angle (θ) with OX_1. At output level AA', the average student receives Ox_1 units of purchased resources and allocates Ox_2 units of his own time. An above average student (P) in this class is represented by the ray OS which makes an angle θ' with the horizontal axis. Because of his superior efficiency, this student allocates not Ox_2 but Ox_4 amount of his time, which he (and his parents) attempt to combine (for example, by finishing assignments early and requesting additional work) with not Ox_1 but Ox_3 units of purchasing resources, thus attaining an achievement level represented by BB'.

Suppose, however, that the teacher insists on providing him with only the amount of resources used by the remainder of the class and that (because both parents work) he is not able to supplement the school resources in the home. If he continues to provide Ox_4 amount of his own time, he will achieve only at the level CC'. This, however, is the level of attainment which would be reached by a student whose ability is represented by the line OS'', which makes an angle θ'' with the origin. In other words, by withholding extra attention and resources, the teacher transforms student P into an "underachiever."

Differences across subject areas in student time value. Our theory will also speak to the question of the allocation of the time of a given student across subject areas or curricula objectives. The assumption again is that students may exercise some discretion with respect to their time allocation among subjects through homework, and through attention or inattention in class. The amount of time a student will allocate to subject matter A depends on the rewards he can

attain (in particular, the rate at which new learning in subject A can be produced) and the cost of foregone opportunities, in this case, the opportunities to learn other subjects. In fact, the opportunity cost of a students' time is equal to the best alternative available to him, so that the cost of time allocated to subject A is determined by a student's efficiency in his best subject area. Figure 4-6 depicts some aspects of student choices among subject areas.

Figure 4-6
Student Performance across Subject Areas



As in Figure 4-3, axis $0X_1$ represents the dollar value of purchased resources; $0X_2$ represents amount of student' time, and 0Y represents student performance.

Figure 4-6 represents the performance of one student in two subject areas, E and F. 0E and 0F join points of maximum outcome on the production surfaces of a given student in these two subjects. Since the student is more efficient in F than in E, the amount of learning produced by inputs of $0p_1$ units of X_1 and $0s_1$ units of X_2 is GM in subject E and GN in subject F. The student may be encouraged to improve his performance in E by using more of his time and of other resources, thus attaining at a level DM'. However, he may decide to use more resources in subject F, since he is more efficient in producing learning in that area. If he does so, the gap between the two subjects <u>increases</u> to M'N' from MN.

Whether the optimal allocation of time for a given student across subject areas corresponds to what is socially desirable is an important issue; schools may set performance minima in essential subjects, so that some students are deprived of resources in their "best"

subjects until they reach a required standard in their "worst" subject areas. The example which comes most readily to mind is that of athletes who perceive the marginal product of additional investments in, say, football to be higher than in mathematics and English; colleges may, despite coaches' opposition, set academic standards as requirements for participation in intercollegiate sports.

Summary

The material presented in this Chapter differs from the existing literature in educational management and policy making in two major respects. In the first place, the Chapter views educational organizations as complex decision systems within which individuals playing a variety of roles contribute to the production of learning. In the second place, the Chapter places considerable emphasis on a frequently neglected variable in the production of learning, namely the time of students.

One pervasive function of management as well as a major concern of policy makers is the allocation of scarce resources so as to contribute to the attainment of an organization's goals. In educational organizations, resources are allocated by parents, teachers and students, as well as by administrators and legislators. Decisions made by occupants of all these roles help determine whether educational organizations are efficient and whether the benefits which they provide are equitably distributed throughout the client group. Decision-making within schools is characterized by interdependence; decisions made by each individual result in opportunities as well as constraints on the decisions made by other occupants of the same role, as well as on those of occupants of different roles.

Previous discussions of resource allocation in education have been inadequate in two major respects. In the first place, they have over-emphasized those decisions made by individuals who are formally assigned to administrative or legislative roles. In the second place, they are marked by a preoccupation with purchased resources and a neglect of non-purchased resources, students' time in particular.

Educators have probably always been aware of the value of students' time, and of the loss of efficiency which results when it is wasted. They have often disagreed on the policy implications of this conclusion; some have advocated reducing the amount of time students allocate toward schooling, thus providing them with more total years in which to pursue their vocations; others have argued that since students' time is a major determinant of total learning, students should spend more time rather than less in school. The major concern of economists has been with estimating the value of time which students allocate to schooling, although some have urged that time, once available, should be used productively.

Our approach has differed from that of previous scholars, since we have emphasized the importance of the quality as well as the quantity of time which students provide for schooling, and the effect of student efficiency on the way in which resources are combined in the production of learning. In this Chapter our emphasis has been on the determinants of the allocation of purchased resources among students as well as the allocation by students of their own time. In Chapter 3, we turn to the importance of students' time and other variables in affecting inter-classroom differences in resource configurations.

Footnotes to Chapter 4

1. This aspect of resource allocation in education is becoming increasingly recognized. See, for example, Lau (1977).
2. Katzman (1975, p. 181) suggested that there is "the need for a new breed of school administrator, a public service entrepreneur skilled in decision making for the nonprofit sector of the economy."
3. Williamson (1964) argued that even in the private sector managers will tend, except in industries characterized by extreme competition, to enhance their own self interest rather than to pursue single-mindedly the goal of profit maximization.
4. Lortie (1975, p. 104) found psychic rewards to be more important to teacher satisfaction than extrinsic rewards; the former are closely linked to teachers' perceptions that discernible results have been obtained.
5. See, for example, Cusick (1973).
6. Bowman (1968, p. 787) defined opportunity costs as follows: ". . .The opportunity costs of choosing a commodity, service, or activity . . . are what the individual or group or society gives up . . . in making this choice."
7. Callahan (1962).
8. Thompson (1915, p. 29).
9. Thompson (1915, p. 33).
10. James (1969).
11. Becker (1965); Bloom (1974); Carroll (1971); Block (1971).
12. Bloom (1973, p. 1).
13. Cusick (1973, p. 49).
14. Cusick (1973, p. 56).
15. Harnischfeger and Wiley (1975).
16. Schultz (1961, p. 67).
17. Cubberley (1905, p. 26).
18. Harnischfeger and Wiley (1974, p. 5).
19. Reuter (1963).
20. Tyerman (1968); Cline (1966).
21. New York Times (Feb. 2, 1970, p. 1). For a discussion of the effect of the classroom environment on attendance, see Stallings (1975, p. 102).
22. Douglas and Ross (1965, p. 31).
23. Douglas and Ross (1965, p. 35).
24. Douglas and Ross (1965, p. 37).
25. Douglas and Ross (1965, p. 33).
26. Cusick (1973).
27. Bloom (1974, p. 686).
28. Bloom (1971, p. 54).
29. Report of the Committee of the National Council of Education, John H. Baker, Chairman, 1913, No. 38. "Two-thirds of the correspondents would shorten the period of general education, and the majority of these place the end of college at 20 or earlier. . . "
30. Machlup (1962, p. 144).
31. Report of the Panel on Youth of the President's Science Advisory Committee (1974, p. 162).
32. Individuals might be provided with vouchers that would entitle them to a given amount of education which they could obtain, at reduced rates, over their lifetime. See Kurland (1976).

33. Bloom (1974).
34. Bloom (1974, p. 686).
35. Anastasi (1960, p. 369).
36. Anastasi (1960, p. 370).
37. Bloom (1976, Chapters 3 and 4).
38. Carroll (1971, p. 29).
39. Carroll (1971, p. 31).
40. Christofferson (1971, p. 114).
41. Christofferson (1971, p. 115).
42. Leibowitz (1974, pp. 5111-5131).
43. Becker (1976).
44. Becker (1965, pp. 493-517).
45. Leibowitz (1974, p. 5111).
46. Hill and Stafford (1974, pp. 323-341).
47. Hill and Stafford (1974, p. 331).
48. Hill and Stafford (1974A, p. 332). Susan Stodolsky has pointed out in informal conversation that the actual amount of time mothers spend with children may be less important in fostering the latter's intellectual growth than the manner in which mothers structure the educational environment of the home.
49. Leibowitz (1972) as cited in Leibowitz (1974, p. 5116).
50. Leibowitz (1974, pp. 5128-5129).
51. Hill and Stafford (1974B, pp. 5134-5135).
52. Carroll (1971, p. 41).
53. Bloom (1976, Chapter 5).
54. Wells (1974, pp. 273-281).
55. Tiedout (1956).

Chapter 5

THE TECHNOLOGY OF CLASSROOMS

Introduction

In the previous Chapter we presented a theory of resource allocation in education which is based on the proposition that teachers, parents, and students as well as administrators and legislators participate in formulating educational objectives and in allocating resources so as to attain them. In this Chapter we will propose that, despite the widespread participation of many individuals in allocating resources, the technology of classrooms tends to be patterned and to respond to certain internal and external conditions. We will categorize classrooms according to the stocks and flows of resources which they incorporate and will develop a predictive model from which testable hypotheses about resource configurations at the classroom level can be drawn.

While it is sometimes claimed that classroom technologies are relatively simple and that classrooms across the country are alike in the manner in which they use resources, we take the position that, if classrooms are categorized according to their stocks and flows of purchased and unpurchased resources, substantial differences among classrooms will be identified, technologies will be complex, and the total technology of classrooms may be predicted by the use of explanatory variables which emanate from the theoretical presentation of Chapter 4.

The Chapter will include a discussion of conditions which affect patterns of resource allocation in classrooms. The key variable is the total amount of human capital which is embodied in students; variations in student efficiency are hypothesized to affect the demand by students and parents for purchased resources, the ease with which one input may be substituted for another, and the amount of time which students and parents allocate to the educational process.

The dependent variable in the model consists of differences among classrooms in the quantity and quality of human and material inputs, as well as in the flows of services from these inputs to students. The patterning of resource stocks and flows constitutes the technology of a classroom, the central concept of this Chapter.

In order to pursue these ideas further we define the concept of classroom technology. The definition will permit a testing of hypotheses about the relationship between a set of predictive variables and the configuration of resources in classrooms. The Chapter will conclude with a brief discussion of an empirical study intended to test the propositions presented in the following pages.

Classroom Technology

Education is sometimes called a stagnant industry; it is commonly claimed that there is a pervasive sameness among classrooms, and that little change has taken place over time in educational technology. Proponants of this point of view allege that educators are, as evidenced by their apparent unwillingness to make "adequate" use of libraries and

newer inputs like television and computers, reluctant to substitute physical for human inputs. These critics regard education as a labor-intensive industry; they support this position by pointing out that a very large part of the budget of school districts is used for the salaries of teachers, administrators, and other employees.

Our position differs from that described above; we point to recent developments in economics which challenge the validity of the traditional dichotomy between capital and labor. Human capital, which consists of skills and knowledge embodied in human beings, is analogous to physical capital; it is produced through investments of goods and services; like physical capital, human capital may be used immediately or may be stored for future use as a consumption or investment good; human capital, like physical capital, is subject to depreciation and obsolescence.[1] The education industry is both a user and a producer of vast quantities of human capital. The human capital which is embodied in teachers, parents, students, and other personnel is highly differentiated; the technology of classrooms results from complex combinations of human and physical capital, with little use of unskilled labor. In other words, education is a human capital intensive rather than a labor intensive industry.

Defining Educational Technology

We define a technology as a specific combination of human or material resources or both with a measurable amount of students' time. Examples of technologies are lecturing to a class, tutoring, completion by students of a library assignment, and combinations of classroom discussions with videotape presentations.

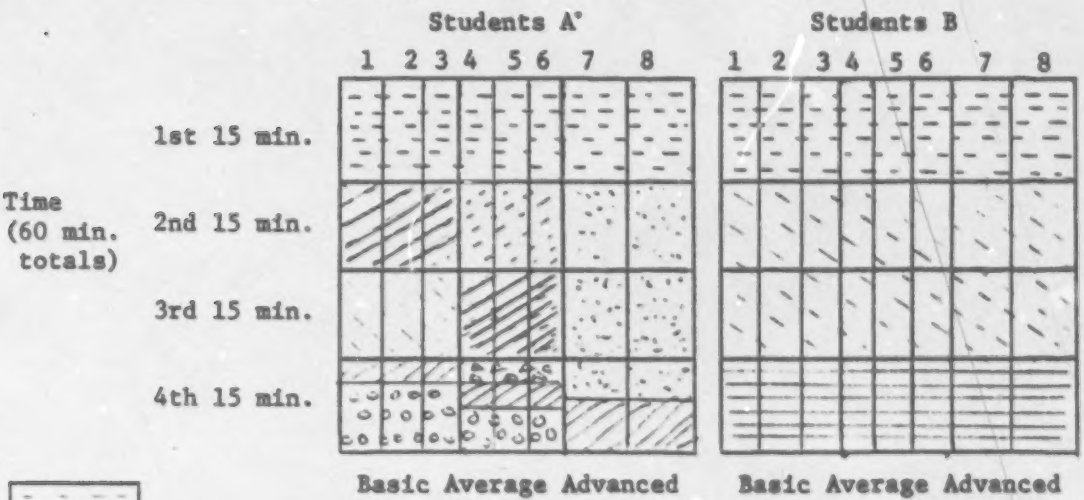
Technological differentiation may be employed in response to variations in curriculum content, or as a means of making the best use of the time of students who possess varying learning styles and capabilities. In many classrooms, more than one technology is used during a given period of time; commonly several technologies are employed simultaneously. The structuring of technologies in a given classroom is termed "classroom technology."

We will develop a scale which will permit us to categorize classrooms according to the degree to which their technology is differentiated. The values assigned to classrooms by using this scale will constitute the dependent variable of the study of classroom technology.

Figure 5-1 is a diagrammatic representation of two classrooms, each of which has eight students. The technology of Classroom A is substantially differentiated, while that of Classroom B is relatively simple. The differences in technology within Classroom A are related to differences in efficiency among students; in Classroom B the technology is invariate among students with different levels of ability.

Figure 5-1

Diagrammatic Representation of Classroom Technology



Teacher making presentation and assigning work to some or all students

Students doing "seat work" under teacher's direction

Small group receiving special help from teacher

Group of students working on programmed learning materials

Group of students conducting research assignment using books, and other materials

Teacher correcting assignment with the entire class

Students working in pairs to correct deficiencies

Students taking diagnostic test

An examination of Figure 5-1 suggests that it is possible to distinguish the overall technology of a classroom by mapping the various technologies which are in use. Classroom A relies on a greater number of technologies than does B; the technologies of A are adapted to students' efficiency; in A, individual students are more likely than in B to utilize a variety of resources in a given time period because students in A benefit from services derived from equipment, books and material while the teacher is instructing other students.

The mapping of technologies provides more information about resource allocation than can be obtained from an inventory of resource stocks, since the former procedure depicts the flow of services from resources to students. To a considerable degree, information about resource flows in Figure 5-1 is implied rather than explicitly indicated. For example, the Figure suggests that the teacher in Classroom A probably provides such services as organizing the classroom technology, diagnosing students' weaknesses, providing special treatments, and evaluating progress; since the teacher in Classroom B relies less on books and other materials than her counterpart in A, teacher B's services include, to a greater degree than the A's the direct imparting of knowledge. The services provided by students also differ; students in A may participate in selecting goals and the means to achieve them to a greater degree than the students in B. The students in Classroom A are more likely than those in B to substitute material resources for the services of teachers in the production of learning.

A prime concern of students of educational technology is the improvement of the productivity of instructional systems. Studies of technology and productivity have for the most part been based on comparisons between the costs and effectiveness of traditional procedures and of the new technologies, such as computer-assisted instruction, television instruction, and programmed learning materials.[2] Two criticisms are made of these studies. In the first place, technological change rarely consists of the simple substitution of one input for another; rather, it involves new mixes of a variety of inputs, including teachers' time, students' time, and material inputs. In the second place, cost effectiveness studies usually include only a small range of measures of effectiveness and cost. In particular, such studies are invariably based on monetary costs and they ignore the opportunity costs associated with the use of students' time.

Cost-effectiveness studies designed to measure differences in educational productivity among classrooms which are characterized by differences in over-all technology should therefore be based on a comparison between achievement gains for groups of students who vary in learning efficiency and broad-based measures of cost which include both monetary and non-monetary components. Such research would consider the possibility that the classroom technology will have different effects on students of high, medium, and low ability levels. It would also take into consideration the possibility that productivity may be improved by avoiding waste in the use of students' time; if all other factors are equal there is a direct relationship between productivity and the ratio of students' total time on task to the total time provided by the school.

The Relationship between Classroom Technology and the Stock of Resources

The stocks of resources which are available for use within classrooms constitute the essential link between the amount of money which is spent on education and the flow of services to students, since money is used to build schools, hire teachers and other persons, and purchase books, material and equipment. Purchased inputs are in turn combined with students' time to form classroom technologies, which are

designed to bring about learning. Decisions about the allocation of money among purchased inputs are made by school boards and administrators, who often solicit recommendations from teachers. Decisions about the manner in which resource stocks are combined with students' time in classrooms are made by teachers and students.

The stock of human and material resources to be found in classrooms is a function of educators' views of the roles of teachers and students. In a recent article, Getzels discussed the relationship between classroom resources and theories of learning, using as examples four types of classrooms.[3] In the first, the space is rectangular, pupils' chairs are in straight lines and are bolted to the floor, and the teacher's desk is in the center front of the room. In the second classroom, the space is square, the pupils' desks are movable, and the teacher's desk is in the corner of the classroom. In the third, the classroom is square and the pupils' desks, being trapezoidal in shape, can be placed in a circle; there is no teacher's desk. In the fourth, the classroom is much larger and has no teacher's desk or pupils' desks, but is filled with a variety of "odds and ends, from fish bowls and birds' nests to drawing boards and Cuisinaire rods."[4] He suggested that the first classroom is based on the premise that the child is an empty organism who learns through the operation of rewards and punishments administered by the teacher; the second type of classroom is based on the notion that the child is an active learner and that the child, not the teacher, is the center of the learning process; the third classroom is based on the idea that the child is a social organism learning from interaction with others; the fourth classroom is based on the belief that the child is a stimulus seeking organism who learns because it is in his nature to do so.

As Getzels' article suggests, educators and architects tend to design school buildings, purchase furniture and equipment and hire personnel in conformance with current philosophy and theories of learning. Since views about education change while buildings and furniture endure, older buildings often inhibit the introduction of new approaches to education. Although there are numerous examples of successful renovation programs, long-lasting inputs often act as constraints on the types of technology which may be used.

A second type of constraint which affects the quantity and quality of books, equipment and materials in classrooms is imposed by the budget of a school system. The availability within classrooms of material inputs is limited by the total amount of money which is provided. Equally important is the fact that substantial portions of the budget are committed for salaries and fixed costs such as pension contributions, interest payments, and levies for social security and workman's compensation funds. The financial resources which are available for the purchase of classroom inputs after these requirements are met are often quite small.

The technology of classrooms is therefore limited by the availability of physical as well as human resources. The mere presence of a given set of inputs does not, however, predetermine the technologies which are used. The relationship between inputs and technologies is mediated, within classrooms, through decisions made by teachers, parents,

and students. We believe that these decisions are patterned in a fashion which can, through the use of the theory developed in Chapters 2 and 3, be systematically examined. Before we discuss the proposed methods of determining these relationships we present, in the next section, a more formal analysis of the relationship between expenditures, inputs, and technologies.

Money, Resources, and Technology

Summarizing the previous discussion, members of educational systems, including students and parents as well as teachers, administrators and school board members make decisions about resource allocation in keeping with the educational objectives which they value. While the various members of the system may differ in the priorities they assign to various objectives, a substantial measure of agreement is attained as a result of the fact that school board members, being elected, are accountable to the public; they in turn select school administrators who have the responsibility for purchasing inputs, and in particular hiring, firing, and granting tenure to teachers. In order to attain the objectives which they separately regard as important, teachers and students determine educational technologies by combining students' time with teachers' time and other resources.

Each technology is a specific combination of students' time with other resources, as indicated in Equation (1) where X_k is the k'th technology utilized in a single time period.

$$X_k = \begin{vmatrix} x_{k,1} \\ x_{k,2} \\ \cdot \\ \cdot \\ \cdot \\ x_{k,g} \\ \cdot \\ \cdot \\ \cdot \\ x_{k,n} \end{vmatrix} \qquad (1)$$

In equation (1), $x_{k,g}$ is the amount of the g'th resource utilized in the k'th technology in a single unit of time. The total amount of each resource which is used by a given student over a period of a day, a week, or a year in the implementation of technology "k" is therefore the product of the amount of time allocated by student "i" to technology "k."

The total resource commitment to the education of student "i" therefore depends on the sum of the technologies used, namely

$$\sum_{k=1}^{k=r} t_{k,i} X_k$$

in which the symbol Σ indicates that the terms are added. For each student, this expression can include technologies employed for learning in the home as well as in the school.

We now move to the classroom level of analysis, as represented by Figure 5-1. At this point, we turn to the concept of classroom technologies represented by Y_k, representing a specific combination of purchased resources with the time of one or more students. The formal definition shown in Equation (1) applies for Y as well as for X, with $t_{k,j}$ standing for the amount of time devoted to technology "k" by the j'th group of students. The total classroom technology (2) is represented by the sum of the separate technologies:

$$Z = \sum_{k=1}^{k=r} t_{k,j} Y_k \qquad (2)$$

("r" is the number of classroom technologies in use.)

The translation of (2) into resource requirements is shown in Figure 5-2.

Figure 5-2

The Technology of a Classroom

		Technologies			
		Y_1	. . .	Y_k	. . . Y_r
Inputs	x_1	$t_1x_{1,1}$	. . .	$t_kx_{k,1}$	. . . $t_rx_{r,1}$
	x_g	$t_1x_{1,g}$	. . .	$t_kx_{k,g}$	. . . $t_rx_{r,g}$
	x_n	$t_1x_{1,n}$	. . .	$t_kx_{k,n}$	. . . $t_rx_{r,n}$

Figure 5-2 translates Figure 5-1 into resource requirements. The columns multiply the amount of time allocated to each technology by the amount of each input which is used in that technology during a given period of time. The rows indicate the amount of each input used in implementing classroom technologies. Since the cost of the inputs can be determined by simple accounting procedures, the total cost of implementing a set of procedures in a classroom can easily be determined.

At any point in time, the nature of the technological mix which may be implemented in a classroom is constrained by the availability of purchased resources and of students' time. To begin with, the total amount of money which is available sets limits on the amount of teachers' time and physical inputs which may be purchased.

$$R \geq \sum_{k=1}^{k=r} \sum_{g=1}^{g=n} P_g \, (t_k x_{k,g}) \qquad (3)$$

where P_g is the price of the g'th input.

$t_k x_{k,g}$ is the amount of resource x_g used in technology k; $P_g \ (t_k x_{k,g})$ is therefore the cost of that portion of the g'th input which is used in k'th technology. Since the total amount of money spent cannot exceed R, decisions concerning the over-all level of expenditures set limits on the possibilities which exist for new decisions to be formulated.

Some previous decisions also constitute constraints which are in effect over a fairly long time period; this applies particularly to the cost of school buildings and of hiring and granting tenure to teachers. In the intermediate term, teachers then have been hired and many of them have been given tenure. The amount of money which remains and which is available for purchasing other inputs such as books, equipment, and teaching supplies is therefore limited by the amount of money which is committed to teachers salaries.

$$R_m = f \ (R, R_T) \qquad (4)$$

where R_m is the amount of money available for books, equipment and supplies, R is the total budget, and R_T is the money committed to teachers' salaries.

In addition to the budget constraints, there are a number of other limitations to the total technology which are imposed by the amount of time of teachers and students which is committed to education. In the first place, the amount of teachers' time which is available for a specific technology is limited by the total amount of teachers' time which has been purchased, and the portion of that time which is used in other technologies.

$$t_h P_T x_{h,T} = R_T - \sum_{k=1}^{k=h-1} P_T \, t_k x_{k,T} - \sum_{k=h+1}^{k=r} P_T \, t_k \, x_{k,T} \qquad (5)$$

where t_k is the amount of time devoted to the k'th technology P_T is the price of a unit of teacher's time. $x_{k,T}$ is the amount of teacher's time devoted to technology k. R_T is the total amount of resources available for the purchase of teacher's time.

The other major constraint is imposed by the amount of students' time available for use in a day. Assuming that homework can be assigned, the total potential amount of students' time, represented by S is that which is used in all the technologies in which students are involved.

$$S = \sum_{k=1}^{k=r} t_{k,j} \qquad (6)$$

where $t_{k,j}$ is the amount of time of the j'th group of students used in the k'th technology. (Y_k).

However, the time actually supplied by students to their education (S_a) is usually less than S. It is assumed that the amount of time students supply is determined by the costs and benefits which they perceive.

$$S \geq S_a = f(C_r, C_o, B_e, B_p)$$

where C_r is a vector of real costs, C_o is a vector of opportunity costs, B_e is a vector of economic benefits, and B_p is a vector of psychological benefits resulting from education.

Determinants of Classroom Technology

Scholars concerned with education have for many years been engrossed in the study of variations in classroom practice. Their work has been at times philosophical, at times ideological; more recently the emphasis has been empirical, as social scientists and ethnographers have attempted to explain how classrooms "work."[5] There have, however, been few attempts to explain inter-classroom differences. We propose that classrooms differ systematically in their technology and that these differences can be explained in part through the use of the theoretical propositions which have been presented in Chapter 2.

Our dependent variable is technological differentiation or complexity. A scale will be prepared which will permit the classification of classrooms along a continuum, from the most to the least diferentiated. The scale will evolve from Figures 5-1 and 5-2 and will incorporate such phenomena as the abundance and variety of human and material resources, flexibility in the use of time, the adaptation of technologies to the characteristics of students, and the degree to which students are involved in selecting objectives and technologies.

Two broad categories of factors are assumed to affect classroom technology. The first category consists of the demands placed on the educational system by parents and students; the second includes those technical factors which are associated with input substitution.

Demand Variables*

There are differences among parents and among students in the demands they place on the schools; some clients exert greater pressure on teachers and administrators than do others. Because there is a tendency for parents with similar preferences to live in the same community, the demands placed on the schools will differ among classrooms which serve attendance areas of varying social and economic characteristics.

We hypothesize that, in general, classrooms serving upper middle and upper class families will utilize more and better resources, and will provide a more differentiated technology than classrooms serving lower middle class and lower class families. This is because the former type of family is, on the average, more likely than the latter to have

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*The term demand is not used in the economic sense; because those specific services which are provided by grade schools are seldom bought and sold in the market place, their price is not determined by the forces of supply and demand.

invested heavily in the development of their children's capabilities in the preschool years as well as after children enroll in school. Therefore, at all grade levels, students in communities of superior educational and income levels will, by and large, have accumulated substantial amounts of human capital; students' time will be treated as a valued commodity and will be combined with a greater than average amount of purchased resources.

The relationship between pupils' capabilities and school resources comes about in several ways. For example, parents of high educational levels seek out communities and schools in which their children will have access to superior resources.[6] Such parents also have the knowledge of the political system which permits them to influence the behavior of school board members and administrators with the purpose of improving the inputs which are available in their children's schools.

At the micro level, parents and students place demands on teachers which are intended to bring about a recognition of the embodied human capital which students have accumulated. Parents of high ability children demand that their children be permitted to pursue subjects in greater depth than do children of lower ability. The more efficient students tend to finish their work more rapidly than those who are less efficient, and the former therefore indirectly "demand" additional resources. Technical differentiation therefore results in part from the pressures which are exerted on teachers to make effective use of the time of students who embody substantial amounts of human capital but work at different rates, value different objectives, and utilize varying procedures for acquiring additional knowledge and skills.

There is, however, another set of factors which are relevant to an explanation of differences in classroom technology; these factors consist of the technical conditions which characterize the production of learning in schools.

Technical Conditions Affecting Resource Combinations

Since the pursuit of learning is a unique enterprise, the careless application to education of models and theories developed to explain other types of activities may lead to conclusions which are at best dubious and at worst ridiculous. Nonetheless, the relationship between client demand and classroom technology, developed in the preceding section, is sufficiently general as to appear plausible in the present context. In this Section we deal with another set of factors, technical rather than political in nature, which underly most discussions of educational production. Here we make explicit what to other analysts is often implicit, and we thereby permit our readers to examine the application of procuction theory to education.

A general proposition which is applied to many aspects of human activity is that as one input becomes expensive in relationship to others, attempts will be made to substitute the less costly for the more costly inputs. Thus, as coffee becomes relatively expensive, people buy more tea; as servants' wages go up, households purchase labor-saving equipment; when metals become relatively costly, industries switch to plastics.

Some will argue that the principle does not apply to education, either because education is a special case to which economics is irrelevant or because educators, by nature obdurate, are unwilling to accede to the principles which govern all other parts of our life. Both arguments are simplistic; we maintain instead that input substitution in education is more complex than in most other activities, since education is produced through the combination of a variety of types of human and material capital and, in contrast to the manufacturing industries, non-purchased inputs are a major factor in the production of learning. In fact, the value which is assigned to students' time is the pivotal variable in determining how input substitution will take place in education.

We therefore test the following hypothesis: in those attendance areas in which the shadow price of students' time is relatively high, there will be a tendency to combine students' time with a greater than average dollar cost and a substantial variety of purchased inputs; in attendance areas in which the shadow price of students' time is relatively low, the tendency will be to treat students' time as having little value by combining it with purchased inputs which are inexpensive and limited in variety.

An important issue, discussed in Chapter 4, is the degree to which inputs may be considered to be possible substitutes for one another. Since this issue is seldom discussed, it may be assumed that educators are sceptical about the notion that substitution among inputs is an important element in the production of education. This point of view appears in the cliche that "there is no substitute for" an individual's favorite resource--a well-trained teacher, a good library, blackboard and chalk, or a set of basal readers. However, there are many examples of input substitution, especially when students' time is considered to be the focal input. For example, when examination time approaches, college studetns may hire a tutor, who helps them conserve what has become a scarce resource, the time remaining before the examination. On the other hand, when time is more plentiful, individuals may make extensive use of public libraries or may enroll for courses in "open universities" which permit the substitution of students' time for that of instructors.

The lack of interest, among analysts of educational production, in the concept of input substitution may result from their preoccupation with policy issues at the macro level; when data are sufficiently aggregated, differences among and within classrooms in the manner in which inputs are combined become obscured. However, when the production of education is viewed from the micro level, input substitution becomes a pervasive phenomenon. Within classrooms, teachers frequently act as managers of learning systems, rather than as fountains from which information flows to students. Students' time is combined with books, equipment and materials, and the time of peers, as well as with teachers' time, in the formulation of classroom technologies. At the college level, students assume the role of managers of their own learning-producing systems, combining their time with that of professors, teaching assistants and peers, as well as with the services which emanate from libraries, laboratories, and textbooks.

Our discussion in Chapter 4 of input substitution was based on the assumption that the degree to which one type of input may be substituted for another is dependent on the properties of the inputs themselves. This assumption permeates much of the discussion of educational technology which deals with the conditions under which alternatives to traditional instruction (such as language laboratories, computer terminals, or television) may be used. There is another approach to the issue of input substitution, namely, that the ability to substitute one input for another in the production of learning is a function of the learner and not of the inputs. This point of view depends on the notion that an important aspect of learning efficiency is the ability of the learner to substitute one kind of input for another. If this kind of ability is well developed students may utilize a variety of resources, while teachers are enabled, for example, to assign to one group of students a project requiring material resources while she gives personal attention to another group.

This is an important concept for students of educational finance. In our present schools, the mix of human and material resources is remarkable alike in the early grades and the senior grades of high school; only in college are students faced with the need to make substantial use of nonhuman inputs, in particular, the library.* If the longitudinal model of the production of learning which was elaborated in Chapter 4 were taken seriously, the resource mix would change gradually through the grades, with students' reliance on teachers as the primary source of information gradually diminishing as students improve in their ability to obtain and process information from non-human sources.

The ability of decision-makers in classrooms to substitute one form of input for another in the production of learning depends on the availability of suitable non-human resources. The availability of alternatives to the services of teachers depends on the flow of new inventions which are appropriate for classroom use, the demand for new resources on the part of teachers, parents, and students, and both the ability and the willingness of administrators and school boards to supply funds for such services. A final constraining factor is the degree to which the newer inputs become part of the total learning system. Policy advocates with a technocratic bent are sometimes indignant over the reluctance of educators to use such devices as television, computer terminals and teaching machines as substitutes for teachers' time; experience has shown that such inventions are rejected by an educational system when they are not incorporated into the total decision-making matrix. Modifying the entire system to incorporate newer procedures and devices may be time-consuming and frustrating, but there may be no other way to bring about fundamental change in classroom technology.

Summary

Our purpose in this Report is to identify the linkages which exist between educational finance, the resources which are available in

*To be sure, some colleges are like high schools, in the heavy dependence placed on classroom instruction, and the relatively minor use of the library.

classrooms, and educational technologies which are utilized in the production of learning. While educational finance decisions are made by school boards and state and federal governments, and the availability of classroom purchased resources results from budgetary decisions at the school district level, resources are combined in homes and classrooms to produce technologies. However, despite the diffusion of decision making, the resulting pattern of classroom technologies can be described, and general influences on the configuration of resources at the classroom level can be identified.

The purpose of this Chapter has been to provide the basis for categorizing classrooms according to their technology, and developing a theoretical model of the factors which affect classroom technology. Our first step is therefore to develop a scale of technological differentiation; this scale will be based on such factors as the amount, quality, and variety of available resources, complexity in resource flows, flexibility in the use of time, and formal recognition of students' role in decision making within classrooms.

Two sets of explanatory variables have been identified. First, there are the demand variables, consisting of those variables which are related to the intensity and diversity of demands by parents and students for school resources. Second are the technical variables, consisting of constraints and opportunities imposed by the nature of the inputs, the characteristics of students, and the differences among areas of the curriculum. The simplified model includes (a) background or environmental variables, (b) variables which are intermediate because they are affected by the environment and affect the dependent variable, and finally (c) the dependent variable itself, consisting of the level of differentiation of the classroom technology.

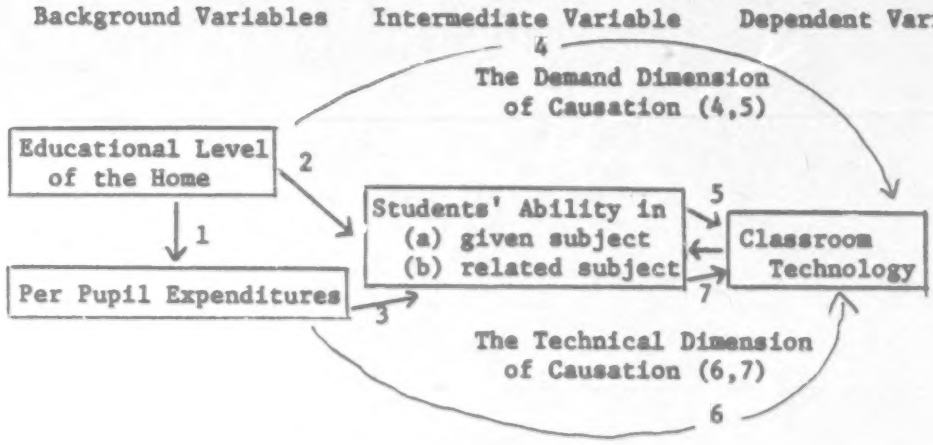
The first general background variable consists of the learning environment provided in homes; differences in the effectiveness of homes as educational institutions affect the amount of capital students accumulate before entering school and even after they are enrolled; these differences in turn influence the manner in which students' time is combined with other inputs. The average educational level in the school's attendance area will be used as a proxy for the home learning environment for comparisons among classrooms; we will use questionnaire data to provide information about differences among homes of students within classrooms. The second background variable of interest is the level of expenditures per pupil for a given classroom. This information provides a measure of the amount of money available for the purchase of inputs.

The intermediate variable in the model is the average level of student ability in the given subject area and in related subjects. This datum is an estimate of both the amount of human capital possessed by students, and students' ability to produce additional capital. Students' ability affects classroom technology for reasons which are related to both the demand dimension and the technical dimension of the model. In the first place, the amount of human capital which students have accumulated at a given point in time affects the demand expressed by parents and students for resource quality, quantity, and variety. In the second place, students' ability helps determine the value which is assigned to students' time, and hence the nature of the combinations of students'

time and other resources; additionally students' ability affects the degree to which they are able to substitute material resources for teachers' time in the production of learning. Figure 5-3 is a simple diagrammatic representation of the relationship between these categories of variables and the dependent variable, the degree to which the classroom technology is differentiated.

Figure 5-3

Classroom Technology: An Explanatory Model



The propositions stated in Chapters 4 and 5 are at times tautologies, at times hypotheses intended for empirical testing. In the next stage of our work we will gather and analyze data from a sample of classrooms in order to test the efficacy of the hypotheses. These findings will, in turn, have important implications for educational finance, management, and policy making.

Footnotes to Chapter 5

1. Becker (1966); Schultz (1971).
2. See Jamison, Suppes, Wells (1974).
3. Getzels (1974, pp. 527-540).
4. Getzels (1974, p. 527).
5. Jackson (1968).
6. Tiebout (1956).

Appendix A*

A MULTI-LEVEL STUDY OF RESOURCE ALLOCATION IN EDUCATION

Abstract

Most studies of resource allocation in education have centered on decisions made by school districts, states, and the federal government. However, important allocation decisions are also made at the micro level by students, parents, and teachers. These decisions are especially salient if we include non-purchased resources, especially students' time, in the analysis.

A multi-level study will examine the interrelationships between decisions made at the several levels. The resources available to decision-makers at the micro level are to a degree, but not altogether, determined by decisions made at higher levels. On the other hand, observations of the flow of resources at the level of the school district result, in part, from the aggregation of individual decisions made in homes and classrooms.

Introduction

This is a request for additional funds to extend the research which was funded in the initial phase by the National Institute of Education.** The justification for this request is presented in the body of this Proposal. The following general comments are appropriate at this time:

(1) The scope of the work has been extended since the work was begun. Instead of several papers of modest size, as promised in the Proposal, the project has now been extended in both breadth and depth, so that the Principal Investigator is now planning to present the final report in the form of a book-length manuscript.

(2) Since the project has become increasingly complex, several empirical studies will be required for the testing of hypotheses derived from the theory. The proposal describes the first phase of the research. At least one doctoral study, at present in the planning phase, will also contribute to this field of enquiry.

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*I wish to acknowledge the criticism and advice of Philip Jackson and Douglas Windham, whose suggestions have been incorporated in this proposal. In addition, Charles Bidwell, Benjamin Bloom, Dan Lortie, and Douglas Windham read and criticized the manuscript on which the proposal is based.

**NIE-G-74-0037.

Rationale for the Proposal

This section summarizes the conceptual basis of the research. It is drawn from Chapters 4, 5, and 6 of the manuscript; readers are referred to the text for a more complete presentation of the theory on which the proposal is based.

Three types of proposition form the basis for this rationale. The first is that decisions concerning resource allocation in education are made at several levels, including: (a) school districts, (b) the state and federal government. and (c) the individual child, parent, and teacher. The second proposition concerns the importance of non-purchased inputs, while the third deals with the concept of educational technology.

(1) Levels of decision-making. It is frequently assumed that the two main objectives of resource allocation policy in education, namely, the improvement of efficiency (or productivity) and increasing equality are determined by decisions of state and federal policy makers and school district officials. In accordance with this belief, many states are attempting to make educational systems more productive by passing laws requiring the establishment of "accountability systems." Such laws, which often incorporate minimum standards for graduation or for promotion from grade to grade, are intended to affect the behavior of teachers and students so as to improve educational productivity. While these laws may bring about changes in curricular priorities, they may not have changed those aspects of teachers' and students' behavior which are related to the teaching-learning process.

It has also been widely assumed that macro-level policy can be used to bring about the goal of "equalizing educational opportunity." While this goal is ill-defined and probably undefinable, a variety of types of policy have been advocated, all with the intent of reducing inequalities in educational opportunity. One such policy, which has engaged the attention of legal experts as well as economists and school finance personnel, is to change the procedures by which state funds are allocated among school districts, in order to bring about greater inter-district equality in expenditure level.

There is little doubt that the reduction of gross inequities in expenditure levels among school districts within many states is a necessary condition for removing gross differences in the educational environments to which students are exposed. Furthermore, equalization is called for on grounds of fairness, since the distribution of state money among local communities affects the latter's general economic condition. There seems to be little justification, moreover, for the existence of gross inter-district discrepancies in teachers' salaries, with the possible exception of differences which are related to the cost of living. However, there is as yet little evidence that financial equalization will substantially reduce variation among districts in the academic achievement or lifetime income of students.[1]

As one aspect of a movement toward policy-related research in the social sciences, economists and sociologists have in recent years attempted to identify by empirical means the variables which are likely to be most influential in determining educational outcomes. Their pro-

cedure has been to (a) construct an appropriate theoretical model; (b) gather information; and (c) test the model through statistical analysis. This approach rests on the assumption that decisions made at the school district (or, sometimes, the school) level to reallocate money among purchased inputs will affect educational productivity and equality. However, as I show in Chapter 3, the findings of these studies are ambiguous and often contradictory; they therefore do not provide clear directions for policy. This disappointing conclusion reinforces the importance of considering a broader range of methodological approaches, including the analysis of decisions made at the micro level, by teachers, students, and parents.

The study described in this proposal attempts to correct the macro bias which underlies much discussion of policy-making, planning, and management in education, since it is based on the assumption that education is "produced" through decisions made by many individuals, including students, teachers, and parents, as well as by administrators and governmental officials. Furthermore, education is assumed to be intrinsically different from other "industries" because in education decisions concerning technology and the selection and use of inputs are made by students as well as by policy makers and employees.[2]

Educational policy which does not take into consideration decisions made at the micro level may not have the desired effect. Extant approaches to educational management which are based on the assumption that the important choices from among alternative technologies and inputs are made by formally designated administrators may be based on an overly restricted view of reality. Many of the decisions in education which affect efficiency and equity are made at the "lower" levels of the organization, and are at least partially independent of policies determined by administrators, school boards, and legislatures.

(2) The allocation of non-purchased inputs. Studies of resource allocation in education have been focussed on the utilization of money and purchased inputs such as the time of employees (especially teachers), space, books, materials and equipment. An alternative view is proposed, based on the assumption that non-purchased inputs, especially students' time, are of at least equal importance to the above, and that the economics of the production of learning is rooted in the manner in which students' time is combined with purchased inputs.

Economists have, to be sure, performed an important function by pointing out that the time of older students has monetary value, since by spending time in school students are foregoing earnings they could otherwise obtain. The concept of the opportunity cost of students' time is therefore central in the economics of education.

However, the concept of foregone earnings provides only a partial explanation of the value of students' time and may, indeed, lead to some confusion. For example, it is usually assumed in rate-of-return analysis that the costs of primary education are extremely low (and the rate of return therefore very high), because young students do not forego earnings by being in school in this society. I propose a different point of view; the time of young students is indeed very valuable--possibly more so than that of older students--because the

most important period in the formation of human capital may (according to recent research) be the early years of a child's life. The time of young students is therefore valuable because of the foregone learning which results when their time is spent on one set of objectives, one curriculum, or one technology, rather than on alternate objectives, curricula, or technologies.[3]

The opportunity costs of students' time may therefore be viewed in at least three ways. In the first place, there is the traditional view among economists that students' time has value because of the earnings which are foregone when individuals are in school instead of in the labor force. However, child labor laws and the mechanization of household chores have lowered the market price of children's time to close to zero for parents and their children. (A partial exception to this statement, in our society, is the case of farm families in planting or harvesting time--here again, however, mechanization has, in much of the country, greatly reduced the pecuniary opportunity costs of children's time.) A second, and probably more important aspect of opportunity cost is the learning which students forego when they are engaged in one learning activity rather than another. We make a distinction between the development of basic skills ("learning to learn") and the use of these skills in acquiring additional knowledge. Since the "ability to learn" appears to be developed more rapidly in the early years of children's lives than when individuals grow older, and since much learning is sequential in nature, it seems possible that (contrary to the traditional wisdom), the opportunity costs of students' time are greatest in the earlier years of schooling. A third aspect of the opportunity cost of students' time consists of the short-term alternatives which students forego when they are engaged in learning. As we will note below, students' allocation of their own time to learning will be affected in part by the cost-benefit balance established by teachers and parents (a concept which is akin to that of "motivation") and in part by the attractiveness of alternatives to study.

The notion that students' time has value because of the alternative ways in which it may be utilized is a powerful one, in terms of our analysis and its empirical implications. In the first place, students' time has a qualitative as well as a quantitative dimension, since at a given point in time some students have acquired more "human capital" than others, and some students are therefore more efficient than their peers in the production of additional learning. However, the learning efficiency of students also varies across subject areas, as a result of various factors, including developed interests and abilities, as well as genetically determined abilities, and the effect of differing home and school environments.

An important proposition follows from the above analysis. It is postulated that teachers, parents, and students assign a value to students' time which is proportional to the learning efficiency of a given individual in a given subject area. Parents may value their children's time on the basis of previous investments of time and other resources in the learning efficiency of their children. Competent teachers will design classroom environments (or sets of technologies)

as a result of their perception of the learning efficiency (or time value) of individual students. Students will assign a value to their time which is affected by a variety of factors--previous investments, interests, and the relative attractiveness of learning and alternative uses of time. The result of this complex set of valuations is a process in which the decisions which are made by teachers and parents are most visible, while students retain the discretionary power to use their ability to create additional human capital or to devote their time to "consumption type" activities.[4]

Quantitative variations in students' time available for learning are also important. One aspect of this phenomenon is that there are variations among school systems in the length of the school day and the school year, as well as in the manner in which students' time is allocated among curricular areas. Less obvious, however, is the fact that students supply their own time in varying amounts, as manifested by differences in school leaving ages, truancy, cutting classes, inattention, and homework. Thus, differences in the time supplied by students are probably more important than differences in the time provided to students. Furthermore, if we assume that students supply their own time in accordance with their perceptions of the associated costs and benefits, clues may be obtained concerning the use of incentives to affect micro-level behavior.

Students' time is combined with purchased resources in various proportions. It is assumed that these combinations depend in part on the relative cost of the various inputs, and in particular on the value assigned by students, parents and teachers to students' time. Thus, while other researchers have concentrated on attempting to determine the relationships between (a) specific mixes of purchased inputs and (b) various types of educational outcomes, this study focuses on substitutions which are made among inputs as a result of the value which is placed on students' time. It is believed that this approach will be especially useful in the development of hypotheses about the relationships between resource allocation decisions made at the several levels. It also makes possible a new approach to another important concept, that of "educational technology."

(3) Educational technology. Thus far, students of educational productivity have not dealt explicitly with the concept of educational technology. Economists have avoided the issue by assuming that schools are already technically efficient; they are therefore free to consider the issue of allocatory efficiency--that is, the degree to which a reallocation of money among purchased inputs would improve efficiency. This decision by economists is reasonable since the problem of defining and classifying educational technologies is properly one for educationalists. However, the latter have failed to address it systematically and this research attempts to remedy that deficiency.

One common misconception is that educational technology consists of the substitution of physical inputs (such as computer terminals or television sets) for human inputs. This definition is incomplete because it ignores one of the most important lessons taught recently by economists, that human capital and physical capital are

analogous. Most of the capital used in the production of education is human; furthermore, human capital inputs in education are highly differentiated. A discussion of educational technology must therefore take into account the manner in which various physical and human inputs are combined.

I therefore define an educational technology as a unique combination of inputs, based on an educational rationale. Since the ubiquitous form of human input used in education is the time of students, a more refined definition is the following: an educational technology consists of a unique combination of students' time with other human and physical inputs. It will be shown that this definition of educational technology makes possible an explication of the relationship between resource allocation theory and educational practice, thus throwing new light on the analysis of efficiency and equality in education.

Conceptual Basis

The studies described below are designed to test some of the principal aspects of the model. I begin with a brief statement of the conceptual basis of the study, drawing from Chapter 6 of the manuscript.

(1) Educational objectives are reached through the use of a combination of technologies:[5]

$$O_{i,j,k} = g(X_p, \ldots X_r \ldots X_t) \qquad (1)$$

where $O_{i,j,k}$ is the i^{th} objective in subject area j, to be reached by student "k." Technologies are defined in the manuscript as unique combinations of purchased inputs with students' time.[6] Equation (2) defines the "r'th" technology as a vector of inputs.

$$X_r = \begin{vmatrix} x_{1,r} \\ x_{2,r} \\ x_{3,r} \\ x_{4,r} \\ .. \\ .. \end{vmatrix} \qquad (2)$$

In each technology, x_1 is the value of students' time, determined as follows: x_1 = amount of a student's time multiplied by the learning efficiency of the specific student. Learning efficiency is defined in turn as the amount of specific learning in a subject area a given student can accomplish in a given time period, or, alternatively, the inverse of the amount of time he requires to master a given body of subject matter. (Note: The set of technologies defined in equation

(1) is not finite, because students differ in the time they supply to the learning process and in learning efficiency. The latter varies across students; for a given student, learning efficiency varies across subject areas.)

(2) A widely-used phrase in the educational literature is "individualized instruction." This concept is interpreted in this proposal as implying the differentiation of technologies in response to variations in student characteristics. This definition implies that learning is always individualized. since although instruction may insome circumstances be apparently undiiferentiated, the underlying technology will vary among students, because of differences in the time supplied by students, and because of complex variations in student efficiency.

a. In Equation (1) individualization of instruction may imply the existence of variations among individuals in instructional technologies, when the specific objectives and subject areas are predetermined.

b. Alternatively, individualization may imply variations in instructional technology for and among individuals for differing objectives and subject areas.

Thus, a classroom characterized by individualization of instruction may be one in which students are pursuing different learning objectives (within a given subject area) and are utilizing a variety of technologies appropriate to those objectives. Alternatively, students may be pursuing a single set of objectives, and utilizing different methods to reach these goals.

(3) Traditional production function studies are used to determine the mix of resources which will maximize average achievement. This proposed research, on the other hand, is intended to determine the conditions under which technologies (and hence resoure mixes) will change, in response to a variety of factors, including the value of the student input. That is, achievement is an independent rather than a dependent variable.

(4) An important controlling variable in this analysis is the value which is assigned by teachers to students' time. Micro-economic theory suggests that the value assigned to one input will affect the quantity and quality of the inputs which are combined with it. It is therefore hypothesized that when a high value is assigned to students' time, this resource will be used sparingly, and combined with intense amounts of other scarce resources. On the other hand, when a relatively low value is assigned to students' time, students' time is substituted for purchased inputs.

Although the above propositions appear logically self-evident, the following caveats are inserted:

(1) The amount and quality of purchased resources which are available at the classroom level are determined in large party by decisions made at higher levels, by school boards, state legislatures, and Congress. The unpurchased resources which are combined with them are, of course, subject to the determination of decision-makers in the home and classroom. Hence, decisions made at the several levels are interrelated.

(2) While the research is based on the assumption that micro-economic theory predicts some aspects of behavior, it is recognized that teachers and other decision-makers are influenced by a variety of factors, including their personal preferences and their prior training and experience.

(3) Although the research will examine interrelationships among decisions made at several levels, the guiding assumption is that atomistic decisions of parents, students, and teachers will affect resource allocation and technology.[8]

A topic of this magnitude must be approached in stages. In this phase of the work, time and other resources are required for operationalizing the variables, conducting preliminary observations and analyses, and reexamining the basic theoretical propositions. It is hoped that this work will lead to other studies which will, in their totality, provide a definitive testing and refinement of the above propositions.

Design

The analysis will be conducted at two levels, that of the classroom, and that of the individual decision-maker. Studies are required at both levels, to permit the operationalization of the key concepts and an examination of the relationships between (a) the classroom technology mix and (b) the allocation of the time of teachers and specific students.

Technological Diversity and Intensity

These concepts will be examined at the classroom level, since technological mixes will vary among classrooms within schools, as well as among schools within school districts. It is assumed that the mix of technologies will be affected by certain characteristics of the homes and communities which are served by the schools.

More specifically, it is assumed that technical differentiation results in part from a response by parents, students, and teachers to variations in the perceived "quality" of students' time. In general, where students have already accumulated substantial quantities of "human capital," there will be a tendency to use resource-intensive and highly differentiated technologies. This assumption forms the basis for the following hypothesis: All else equal, technological differentiation and intensity will vary directly with the mean learning efficiency of students in a given classroom.

There is, however, another possible explanation for differences among classrooms in technological diversity. This is that educators respond consciously to differences in their clientele, and are more likely to differentiate their technologies when they deal with a heterogeneous population than when their students are homogeneous in "learning ability." Within the limitations imposed by the scope of this study, this alternative will also be explored.

The term "learning efficiency" and its synonyms "human capital"

and "learning ability," which have been used in the previous two paragraphs will be operationalized through the use of certain "proxy variables." One such variable will be a measure of student achievement in mathematics and reading. A set of related variables will include parental education, occupation, and income, since it is postulated that high social class parents invest, on the average, more of their own time and other resources in the potential of their children than do parents of relatively low social class. This assumption, based on research cited in the manuscript, will be questioned in the second part of the research which will focus on individual decision-makers.

Procedures

We have already constructed a composite tape for school districts in Illinois, which combines relevant data from the 1970 NCES State Tape, and Illinois Office of Education School Finance tapes for 1972-73 and 1975-76. The composite tape will be used for selecting a sample of 16 elementary school districts which represent the top and bottom quartiles of median educational level of adults 25 years of age and over and, within each of these quartiles, districts of high and low per pupil expenditure. Within each school district in the sample, one fourth grade class will be selected which is considered by school administrators to be characteristic of the socio-economic status of the district. The initial assumption to be tested is that technological differentiation and intensity will be greatest in the high SES, high expenditure districts, and lowest in the low SES, low expenditure districts; that technological differentiation will be high but intensity low in the high SES, low expenditure districts; and that differentiation will be low and intensity high in the low SES, high expenditure districts.

A rigorous testing of these hypotheses would necessitate a large sample of classrooms and would therefore require more resources than could be profitably used in this phase of the work. The purpose of this study will be to develop indices of technological differentiation and intensity, using the following types of data:

A. The amount and quality of purchased inputs (human and material) in each classroom, which are available, on the average, for each student.

- Teachers, their qualifications, salary, experience, and academic background[9]
- Teachers' aides, their backgrounds, hours of work, and salaries
- Quantities and value of books and other printed materials used by students
- Nature and value of other purchased inputs, including television sets, microfilm readers, tape recording and listening systems, and the like
- Number of hours in the school day and days in the school year

On the basis of these data, and the number of students in the class, a measure of intensity (defined as cost per student hour) will be determined.

B. Information about students

Scores on achievement tests, especially in reading and mathematics, from which will be calculated means and measures of dispersion

Teachers' grades

Parents' occupation and educational level

Time spent at home on homework and other activities directly related to the purposes of schooling

Attendance as a percent of enrollment

C. At the school district level, data will be gathered with respect to per pupil expenditure, the composition of the school budget, and property tax rates for educational purposes. The last variable is taken to be a rough index of aggregate "demand" for educational services.

D. Activity Analysis. Using the definition of technology which is stated above, an analysis of the intensity and differentiation of technologies will be conducted for each classroom included in the study. The emphasis will be on development of procedures for classifying educational systems, according to technological differentiation and intensity, and on the formulation of indices which can be utilized to categorize the technological system of classrooms.

The procedure to be used will be the following: Trained observers will work in pairs in a given classroom, describing (at short intervals) the technologies used in a given classroom, over a period of time when at least four cognitive subject areas are taught. During each period, the activity, number of students involved, and resources used will be listed. Table 1 is a preliminary draft of the type of worksheet to be used.[10]

The analysis will require at least ten hours of obser[illegible]ion by pairs of observers in each of the 16 classrooms. The results [illegible]l be used to develop an index or classification of technological di[illegible]ren-tiation and intensity. Technological patterns will then be rel[illegible]ed to the socio-economic status of the attendance area, and the financial characteristics of the school district. This analysis will lead to the second set of procedures, which will deal with the study of input substitution within classrooms.

Resource Allocation within Classrooms

Introduction

This portion of the study will examine resource allocation <u>within</u> a sample of classrooms. Both purchased and non-purchased resources will be incl[illegible]ded in the analysis.

There have been many attempts to examine the behavior of teachers in classrooms, mainly from a socio-psychological perspective. Some critics have argued that classroom interaction research has added

Table 1

Analysis of Classroom Technology
(Classrooms A and B)

Time Frame	Description of "Activities"	Students and Groups of students Special Characteristics, if any	Resources or "Inputs"
		Classroom A	
1	(a) Teacher demonstrates new concept, (e.g. long division) to entire class	Entire class (25 students)	"x" minutes of teachers' time, with blackboard, etc.
2	(a) All members of class begin work problems (b) Teacher assists students on one-to-one basis	Individual help given to "x" number of students	"y" minutes of each student's time Teacher's time, students' time, textbooks
		Classroom B	
3	(a) Teacher demonstrates new concept to one-third of class	One-third of class (10 students)	"x" minutes of teacher's time
	(b) Teacher's aide helps students with difficulties on one-to-one basis	Individual help given to "y" students--characteristics?	"y" minutes of time of teacher aide
	(c) Students with no difficulties utilize programmed materials	Remainder of students	Programmed materials
4	Groups rotated	Describe	Describe
Entire Period	Cost analysis of classrooms Teachers' and students' characteristics School District financial and socio-economic characteristics. Special characteristics of attendance area (if different from school as a whole)		

The time modules to be observed will be sufficiently short in duration to permit an accurate record to be made of changes in activities, and of the flow of resources to specific students and groups of students.

little to our knowledge about teaching and learning. Westbury reported a widespread disappointment with the results of these efforts, concluding that "Classroom interaction research of the traditional kind is probably not worth the effort involved . . . because it does not have its tasks or questions clearly formulated."[11]

One reason for the lack of success of these efforts may be that such studies have been mainly descriptive or, at best, taxonomic. The study outlined below will examine one aspect of classroom behavior from a theoretical viewpoint. The phenomenon to be examined will be resource allocation; micro-economic theory provides the basic framework; the emphasis will be on the allocation of students' and teachers' time, both of which are considered to be valuable resource inputs. This approach has both strengths and weaknesses. The advantages of the micro level approach over traditional production function studies are that (a) the use of disaggregated data permits an examination of the effect of specific inputs on specific students, and (b) the manner in which inputs are combined in response to differences in student characteristics and curricula can be studied more closely than is possible when aggregated data are used.

Conceptual Issues

(1) It is assumed that important resource allocation decisions are made within classrooms by teachers and students. Since members of both groups are dealing with the allocation of identical resources, there will not always be agreement on the outcomes of their decisions. Three types of decisions are involved in this issue:

a. The first type of decision concerns the <u>supply</u> by teachers of their own time and other resources to students in the classroom.

b. The second type of decision relates to the <u>demand</u> by students (and parents) for resource inputs, including teachers' time.

c. The third type of decision deals with the <u>supply</u> by students of their own time.

The following sections explore these types of decisions in more detail, pointing out, where appropriate, the occasions on which choices made by one category of decision-maker may conflict with those made by another category.

(2) Teachers have the responsibility for allocating their own time and other resources among individual students and groups of students, as well as across subject areas and across specific objectives within subject areas. However, the behavior of teachers in allocating resources cannot readily be predicted, because of opposing economic and non-economic factors, some of which are listed below.

a. Teachers may desire or be encouraged to maximize total value added (total learning, or, in other words, average achievement) within the classroom. This behavior may result in more resources being provided to the more efficient than to the less efficient students. This tendency may be reinforced by a greater demand for resources from parents who have already invested sizable resources in

Again, the theory suggests that students who have already reached a relatively high level of learning efficiency may be more aggressive in their search for purchased resources than students who have accumulated a lesser amount of human capital.

(4) Parents and students will supply resources for the educational process in a manner which is related to their perception of the resulting costs and benefits.

a. In the home, the allocation of the time of parents, purchased resources, and the time of children in the production of human capital appears to be positively related to socio-economic status.[13] This process is continued (through homework and less formal activities) after the child enters school.

b. In school, students supply their own time according to a "student time-supply function." This function is a postulated relationship between the amount of time supplied by students and the cost and benefits associated with the investment of time, as perceived by the students.

(5) Each of the above variables--the supply of resources by teachers, the demand for resources by students and parents, and the supply of time and other resources by students and parents--will vary across subject areas, and among specific objectives of instruction.

Because of these differences, there will often be conflict between the priorities of teachers on the one hand, and those of students and parents on the other. Furthermore, while we may have suggested that parents and students comprise a single decision-making unit, differences in educational priorities between students and parents have important educational consequences.

In many cases, students' priorities will correspond to their area of greatest efficiency.[14] Hence, they will have a tendency to supply their time and to demand purchased resources in a pattern which corresponds to their priorities or interest patterns. Since students' priorities and those of teachers may not correspond, a waste of students' time may result if students withhold their time from activities they think are unimportant. On the other hand, where teachers' priorities coincide with generally accepted educational requirements (in particular those which are associated with substantial social benefits, such as the ability to read and compute), one aspect of the teachers' responsibility is to attempt to affect students' priorities or interests by influencing the costs and benefits the latter perceive--a process commonly called motivation.

Empirical Study

Sample. An intensive study of resource allocation will be conducted within eight classrooms. These classrooms will be a subsample of those selected in the first portion of the study; in the present phase, classrooms will be chosen within which students are relatively heterogeneous with respect to socio-economic status and achievement. The reason for selecting eight classrooms rather than a smaller number is to provide a partial control for the idiosyncratic factors affecting teachers' behavior.

Procedures. The purpose of this phase of the study is to observe and analyze (a) the flow of resources to specific students in a sample of classrooms, and (b) the manner in which these students supply their time to the "production" of learning. In short, the study will deal separately with the supply functions of the teacher and of the individual students. Following the gathering and codifying of the data, the results will be subjected to multi-variate analysis.

Some information will already have been gathered about the classrooms in this sub-sample. At the school district level, financial data including tax rates, assessment per pupil, expenditures, and receipts from the state and federal governments, will have been obtained. In addition, school district budget reports, which detail allocation among expenditure categories, will have been obtained; comparisons between these districts and comparable districts throughout the state will also be made. Socio-economic data, in particular income, educational levels, and occupational distributions at the school district level are available from the NCES tape; from these data, means, medians, and distributions can be obtained.

We will already have examined the classroom technological systems and will have categorized them according to degree of differentiation and intensity. We will have collected data concerning the stock of inputs available for students in each classroom. This information will include the characteristics of teachers and other instructional personnel, books, materials, supplies, and space. The nature of the curriculum, the total amount of time available for instructional purposes, and the classroom time schedule will also have been obtained.

Analysis of Resource Flows. The purpose of this section of the research will be to observe the flows of purchased and non-purchased resources provided to students. Teams of four observers will spend twenty hours in each classroom recording the behavior of teachers and students.

a. Observations of teachers. One research assistant will concentrate on recording the allocation of teachers' time among students. A pre-determined code will be used to indicate the type of behavior, its distribution over time, and the specific students to whom it is addressed. The worksheet will take the following form:

Teacher X
Monday, February 5

Time	Code number of activity	Recipient of activity
	7	8, 11, 14
	2	1 through 12
	3	23, 24, 25

Examples of coded activities: Administrative directions (e.g., reading memo from school principal)
Instructional directions (e.g., begin work on page 23 of workbook)
Asking question of informational nature
Asking question of interpretive nature
Listening to student report

Stop watches will be used to record the time and duration of the various activities.

Pre-coding will result from a careful review of the literature, the operationalizing of a priori constructs, and testing in one or two classrooms.

b. Observations of students. The task of observing the students in the classroom will be divided among the remaining three assistants. In order to avoid the danger of bias in the observations the assistants will not be given prior information about the students. As in the case of observations of teachers, a previously determined code will be used to simplify the observational procedures.

It is emphasized that considerable care has been taken in this proposal to distinguish this methodology from that used in the typical classroom interaction type of research, in order to emphasize that this research is economic rather than psychological or sociological. However, we will utilize advice and assistance from experts in classroom analysis, and their experience will be invaluable in the implementation of our work.

The coding will make it possible to place students' behavior in such categories as curriculum-related activity, participation in activities of an administrative nature, or non-involvement (daydreaming, socializing, or other apparently non-productive activities). The resources used by the students will also be given code numbers. The accompanying worksheet is a first approximation of the type of observation which will be required.

Coding. Three types of code are used in this analysis:

"A" is a student activity code. Examples of categories of student activity are the following:

1. Listening to lecture
2. Listening to administrative instructions
3. Reading aloud
4. "Daydreaming"

(It is assumed that trained observers will be able to determine, in most cases, whether students have ceased to be "involved" in the activity prescribed at that point in time.)

"T" is the code for teacher activity directed toward a given student. Examples of categories of teacher activity towards a student are:

1. Asking student a question
2. Responding to a substantive question
3. Providing a disciplinary type of directive

Table 2

Student Activity Analysis

1			2			3			Student Number 4			5			6			Time Frame
A	T	R	A	T	R	A	T	R	A	T	R	A	T	R	A	T	R	

Note: For each activity listed, please estimate the number of minutes used within the time frame. This worksheet will be refined as the study progresses.

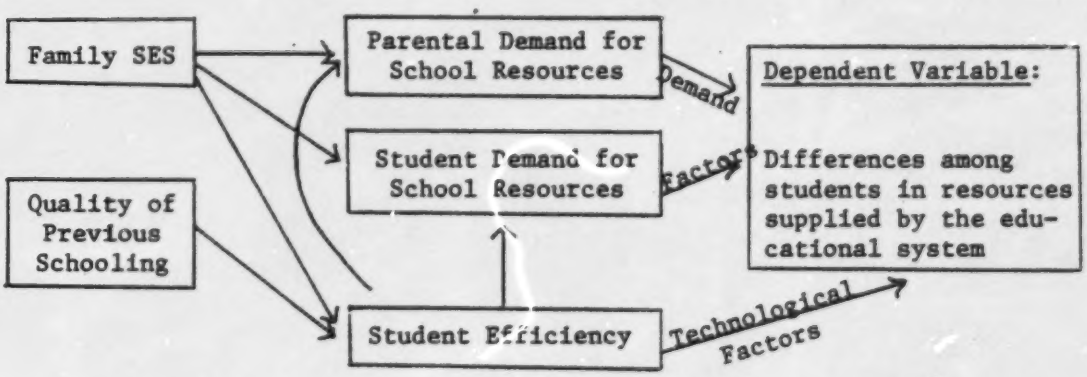
"R" is the code indicating the resources used by the student in the given time frame. Examples:

1. Textbook
2. Microscope
3. Motion picture projector

The purpose of this phase of the research is to test two theoretical models. The first model is based on the assumption that the resources (including teachers' time) which are supplied to students are a function of two sets of variables, (1) variables representing the demand for resources, as expressed by parents and students; (2) technological variables, which are assumed to be related to the value which is assigned to students' time. Figure 1 suggests that these types of variables are interrelated. However, there will be cases where the demand for resources is high and student ability low, as well as cases where student ability is high and demand for resources low.

Figure 1

Variables Affecting the Allocation of Purchased Resources Among Students



The model will be tested through the usual multiple regression procedures, using a variety of variables as proxies for (a) demand by parents for school resources; (b) demand by students for school resources; and (c) student efficiency. Apart from the unusual complexity of the relationships to be studied is the usual issue of multicollinearity. In particular, it will be noted that student efficiency affects the demand for school resources by both students and parents.

The dependent variable in Figure 1 is the variation among students in resources supplied by the educational system. This variable is, however, a composite of various types of resources. Several kinds of relationships can therefore be postulated.

(1) Within classrooms, differences among students in the supply of teachers' time will be positively related to demand variables and positively related to student efficiency.

$$T_{i,t,n} = f(PD_{i,t}, SD_{i,t}, SE_{i,t,n}, C, U) \quad (3)$$

$T_{i,t,n}$ = time allocated by teacher to student i during time t in subject n

$PD_{i,t}$ = demand exercised by parents with respect to student i in time t

$SD_{i,t}$ = demand for teacher's time exercised by student i in time t

$SE_{i,t,n}$ = efficiency of student i in subject n at time t

C = a dummy variable to control for systematic inter-classroom differences

U = a term representing random error

It will be noted that separate regressions are called for according to curricular area. The terms on the right side of equation (3) cannot be measured directly, so appropriate proxy variables must be identified. As always, it must be assumed that the proxies bear a meaningful relationship to the concepts which they are intended to represent. An additional complication is that most of the proxy variables could be related to more than one of the arguments in Equation (3).

(A) The proxies for parental demand are, in the main, SES-type variables
  (a) Occupations of father and mother
  (b) Educational attainment of father and mother
  (c) Educational resources available in the home:
    Books
    Magazines
    Newspapers
    Encyclopedia

(B) The proxies for student demand will be obtained from questionnaires and possibly from school records
  (a) How far do you expect to go in school?
  (b) What occupation would you like to have after completing schooling?
  (c) On the average, how many hours a day do you spend on homework?
  (d) How many hours a day do you spend reading? watching television?
  (e) List your school subjects in order of your preference for them.

(C) Student efficiency variables
  (a) Scores on standardized tests of reading and mathematics to be administered in each classroom
  (b) Teachers' grades in the subjects during which observations take place

(2) The second hypothesis is the following: within classrooms, differences in the supply of all purchased resources will be positively related to demand variables and positively related to student efficiency. The regression equation to be used will be a varia-

tion of equation (3). However, it is not anticipated that the total of purchased resources will be as sensitive to the independent variables as is the allocation of teachers' time.

(3) In view of the caveat noted in footnote 7, it is postulated that purchased inputs other than teachers' time are allocated in a less predictable manner than is teachers' time. More specifically, it is hypothesized that in the less technologically differentiated classrooms, there is a greater tendency to allocate these resources equally among students; while in the more technologically differentiated classrooms, the allocation among students of purchased resources other than teachers' time may be positively related to parental and student demand, as well as to student efficiency, but inversely related to the allocation among students of teachers' time. This is another way of saying that differentiated technologies are characterized by substitution among purchased inputs as well as between purchased inputs and students' time.

Analysis of "Student Time Supply Function." The theory rests heavily on the assumption that students are not merely passive recipients of the resources which are made available to them by the educational system, but that they make decisions about such key allocatory functions as the supply of their own time, and the manner in which their time is combined with other resources. It has also been assumed that students' decisions concerning (a) the allocation of their time; and (b) the selection of appropriate technologies are based on their perceptions of the costs and benefits associated with their decisions.

The latter notion is difficult to operationalize; in fact, it turns out to be tautological, since it merely states that students make decisions in accordance with their expectations concerning the probable consequences. Costs and benefits which directly affect students' behavior are, in the early grades, largely psychological rather than monetary, since while the formation of human capital in the early grades has important benefits in the form of lifetime income as well as monetary and non-monetary costs, it seems unlikely that pecuniary outcomes of education will have an important effect on young students' decisions.[15]

Without discarding the basic assumption that students' decisions regarding the allocation of their time are based on their perceptions of costs and benefits, the theory is revised to include the following assumptions:

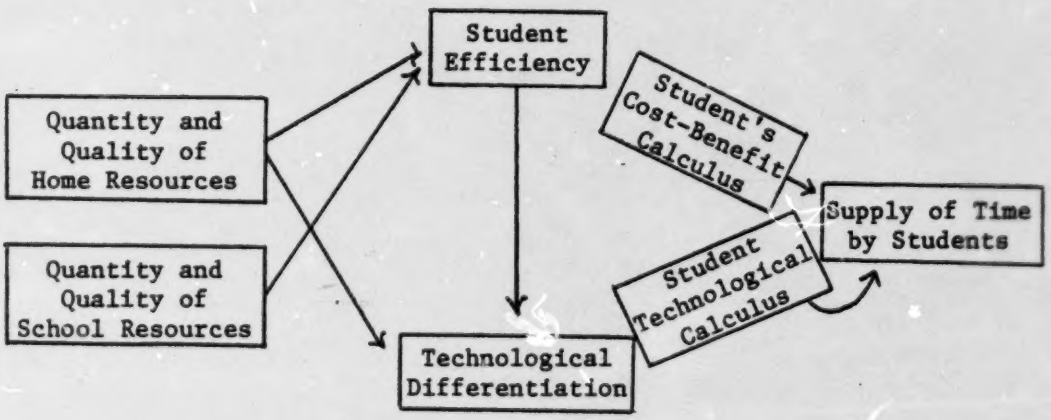
(1) The supply by students of their own time is positively related to the quantity and quality of resources made available to them in their home and their school. The more attractive the purchased and non-purchased resources are to students (in terms of their quantity and quality), the more likely the students are to combine their time with these resources. Thus, well-educated parents, competent teachers with a good background in their subject areas, well-written textbooks, well-equipped science laboratories, and good libraries will induce students to supply their time. Pupils who go to "good schools" and come from "good homes" are therefore often advantaged both in terms of the resources available to them and in their own willingness to supply their time to educative activities.

(2) The total amount of time supplied by students in a classroom will be directly related to instructional differentiation. When instructional methodologies (including, in the allocative dimension, technologies) are differentiated among students, so that each is presented with objectives and resources which are comprehensible and challenging, the total time provided by students will be greater than when all are presented with a common set of objectives and technologies.

(3) The amount of time supplied by a given student will be positively related to that student's ability in the subject area being pursued. The reason for this assumption lies in the general postulate that success in the production of learning is sufficiently rewarding to encourage students to contribute their time. However, a student's time commitment in one area constitutes a cost in another, since by studying subject A, he is foregoing the study of subject B,[16] and it is unlikely that any given student can allocate his time among subjects so as to achieve an equilibrium (at the margin) between costs and benefits, because the priorities set by teachers will seldom conform to students' cost-benefit calculus.

Figure 2

Student Time Supply Function in a Given Subject



Analytic Model

While the dimensions of the differences are not clear, it appears self-evident that some students devote (or supply) more time than others to the production of learning. Furthermore, it is a virtual tautology that the amount of time which students supply is directly related to the benefits they perceive, and inversely related to the opportunity costs of their time. For related reasons, the time supply function for a given student will vary across subject areas.

While even the youngest students have some discretion in the manner in which they supply their time, it would probably be easier to study the time supply function of college students than of elementary

school students, since the former are not subject to the constraining factors which parents and teachers apply to young students. Among elementary schools, the so-called free schools may give greater latitude to student decision-making than do the traditional elementary schools.

Since, because of the nature of the other aspects of the research we are committed to the study of fourth grade students, we recognize that there will be some difficulty in identifying differences among students in the supply of their time. At any rate, the operationalizing of the dependent variable (the supply of time by students) is a formidable task, which will require a large portion of our efforts. Rather than attempting to measure the amount of time supplied in hours and minutes, we will use a combination of measures (classroom observations, attendance records, and student self-reports of time spent on home studies and reading) to develop an index of time supply.

We begin with the theoretical statement:

$$W_{i,j} = g\ (B_{i,j} / C_{i,j}) \qquad (4)$$

Where $W_{i,j}$ is the index of student time supply for student i in subject area j. $B_{i,j}$ and $C_{i,j}$ are the perceived benefits and costs of student i in subject j. It will be assumed that both benefits and costs (as perceived by students) are affected by (a) the quality and quantity of complementary inputs supplied by the home and the school; (b) opportunities for students to make decisions about tecnologies, or those inputs which they will combine with their time; and (c) student efficiency, or success in learning. Hence, equation (4) may be rewritten as:

$$W_{i,j} = g\ (SR_{i,j},\ HR_{i,j},\ D_j,\ A_{i,j},\ A_{i,k},\ \cdots\ A_{i,m},\ I_i,\ U)$$

Where:

$SR_{i,j}$ = a vector of school resources available to student i in subject j,

$HR_{i,j}$ = a vector of home resources available to student i in subject j,

D_j = an index of the technological differentiation of a given classroom,

$A_{i,j}, \ldots A_{i,m}$ are measures of student performance in curricular areas j . . . m,

I_i = a measure of general ability of student i. This measure is taken to be a proxy for previous investments by home and school, as well as of "genetic ability,"

U = an error factor.

Again, these general independent variables will be represented by proxies, such as the following:

(1) Proxies for school resources include:
    (a) Characteristics of teachers
    (b) Amount and quality of other purchased inputs
    (c) Per pupil expenditures
(2) Proxies for home resources include:
    (a) Level of schooling attained by father and mother
    (b) Occupation of father and mother
(3) Other purchased resources available in the home

Because of the problems which are anticipated in both operationalizing and measuring the variables, it appears likely that the formal application of regression techniques will be impossible. Instead, we may resort to simpler types of descriptive and statistical analysis, in order to throw light on the concepts which are under investigation.

Significance of the Study

The broad purpose of the research is to develop a general theory of resource allocation in education which includes decisions made by teachers, parents and students, as well as those made by boards of education, legislatures, and the federal government. In addition, the theory will deal with the interactions between decisions made at these several levels. The theory is also more general than present approaches because it will include an analysis of non-purchased as well as of purchased resources. The empirical work will begin the process of testing the theory.

This approach should contribute to the discussion of efficiency and equity in the distribution of the benefits of education. These discussions are presently hampered by their underlying assumption that policies developed at the macro level can improve both efficiency and equity; this optimism persists despite evidence to the contrary. This researcher does not suggest that macro level decisions are unimportant; rather, he takes the point of view that the production of education takes place within homes and classrooms, and that decisions made by teachers, parents and students are therefore important in the implementation of the goals of states, school districts, and the national government.

Present approaches to educational finance tend to assume that the present institutional framework of education is a constant. The "production approach," which includes the importance of decisions made at the several levels, and incorporates the use of non-purchased as well as purchased resources, encourages a consideration of alternative methods of allocating scarce resources. For example, this approach highlights the importance of the sequencing of investment in education--a topic related to but not identical with the allocation of resources between the development of fundamental skills (learning to learn) and the utilization of these skills in the development of additional human capital.

Existing treatises in educational management give little or no attention to the resource-allocation responsibilities of teachers, parents, and students. However, a wide range of literature strongly suggests that decisions made at the micro level are of key importance in the production of education. The literature on educational management may not make sufficiently explicit the proposition that the education industry is unlike other industries in several respects, including the complexity of the technology and the degree of (and differences in) the participation of the "client"* in the production of his education.

Finally, efforts of economists and sociologists to model the educational process through the production function studies are inadequate for the following reasons:

(1) They assume a centralization of the relevant decisions;

(2) They ignore the importance of non-purchased resources;

(3) They ignore the difference between stocks and flows of resource inputs;

(4) They assume either that educational technology is a constant or that schools are already technologically efficient. In so doing, they avoid the key issue, that inputs are translated into outputs through selection of appropriate technologies;

(5) Their use of aggregated data obscures differences among students in (a) objectives; (b) learning efficiency, and in particular differences in learning efficiency for a given student across subject areas; and (c) the effects of specific technologies on specific students;

(6) Finally, by concentrating on the effect of inputs on outputs, production function studies ignore another key issue, namely, the manner in which input substitution takes place in response to perceived values (or alternative uses) of the various purchased and non-purchased resources which are used in education.

While this study does not attempt to resolve the multiplicity of issues listed above, it hopes to perform the task of challenging existing assumptions. This task continues to be important, if educational systems are to become increasingly equitable and efficient.

Footnotes to Appendix A

1. One reason for the apparent limited efficacy of such policies is that inequalities within classrooms in the allocation of important resources such as teachers' time may exceed in importance inequalities in the distribution of financial and other resources among school districts. See, for example, Philip W. Jackson, "Inequalities of Teacher-Pupil Contacts," Psychology in the Schools, 4, No. 3 (July 1967), pp. 204-11.

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*In defiance of customary practice, we define "client" in this case as including the child, his parents, siblings, and other important out-of-school associates.

2. There are therefore two main differences between the proposed research and production function studies. In the first place, the latter are largely based on the assumption that resource allocation decisions are made by school superintendents or other centrally located administrators; this study suggests that resources are also allocated by teachers, parents, and students. In the second place, this research incorporates the concept of educational technology, while production function research typically assumes that educational systems are already operating at maximum technological efficiency, so that the important remaining decision concerns the allocation of available money among purchased inputs.

3. The distinction between the ideas of foregone earning and foregone learning is not identical with the difference between the pecuniary and the non-pecuniary benefits of education, since the human capital accumulated by young children may be invested in the production of additional learning in the short run, and in income-producing employment in the long run.

4. The process is additionally complicated by the fact that all three groups--teachers, parents, and students--may make erroneous judgments about students' learning efficiency. There is considerable research dealing with the effects on teachers' behavior of misinformation about their students' ability. (See, in particular, Robert Rosenthal and Lenore Jacobson, Pygmalion in the Classroom (New York: Holt, Rinehart and Winston, 1968).

5. Two related but different terms will be used in the remainder of the proposal, namely, the intensity and differentiation of the technological mix within and among classrooms. Differentiation is the degree to which technologies vary across students (or groups of students with similar characteristics) and intensity refers to the amount and quality of purchased resources which are combined, through the technological mix, with a given amount of students' time. Technological differentiation must be observed directly, while intensity can be reduced to the cost per student hour of the flow of purchased inputs to a given student. However, if educational systems are not efficient in their purchase of inputs, comparisons of technological intensity are suspect, unless adjusted for price distortions. This issue is especially salient in the pricing of teachers' time.

I wish, at this point, to clarify a possible misconception. Technological differentiation may sometimes be associated, in the popular mind, with random and purposeless activity. I intend the term to encompass the utilization of resources and methods in such a way as to increase cognitive learning by adapting technologies to differences among students and subjects.

6. An additional theoretical and empirical issue is the extent to which the time of a student's peers should be considered an aspect of the technology to which he is exposed. The importance of peer group effects has frequently been demonstrated in the research literature, suggesting that the time of peers is, indeed, an important non-purchased resource in the production of learning. In economic terms, the contribution of members of the peer group are "spillovers," to the degree

that human capital produced in one child's home affects the school environment of his peers.

7. I am reminded by Douglas Windham that teachers may differentiate the use of their own time from that of other purchased resources. For example, under certain circumstances, they may allocate their own time to the least efficient students, while allocating other purchased resources to students who learn at a more rapid pace.

8. While the technological system which is observed in a given classroom may have been developed by the teacher, the latter is subject to a variety of influences, including those of parents and teachers; for example, students may exercise discretion in their allocation of time to a given activity or a given subject area. Furthermore, capabilities developed in the home as a result of investments made by parents will help determine how well a given technological system will operate. There is therefore in a given classroom an underlying technology which reflects decisions made by members of all three groups.

9. Some difficult issues must be confronted when we use teachers' salaries as a measure of input costs. On the one hand, the study must deal with the possibility that teachers' quality is allocated unevenly among students. On the other hand, since structure of salary scales is not necessarily related to teachers' quality, salary may not reflect the marginal product of the teacher input.

10. Plans are underway to test this worksheet, and to develop new and more appropriate instruments.

11. Ian Westbury, "Teaching: A Sociological View," Paper presented to an invitational conference on research on training, Memorial University of Newfoundland, St. Johns, June 1976.

12. Charles M. Tiebout, "A Pure Theory of Local Expenditure," Journal of Political Economy (October 1956), pp. 419ff.

13. See, for example, C. Russell Hill and Frank P. Stafford, "Allocation of Time to Preschool Children and Educational Opportunity," Journal of Human Resources 9, No. 3 (Summer 1974):323-41.

14. The notion that student efficiency varies across subject areas is important for the analysis.

15. But see also footnote 3.

16. It will, of course, be remembered that the opportunity costs of students' time are also affected by their efficiency in "consumption" type activities, such as competitive athletics, or socializing.

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